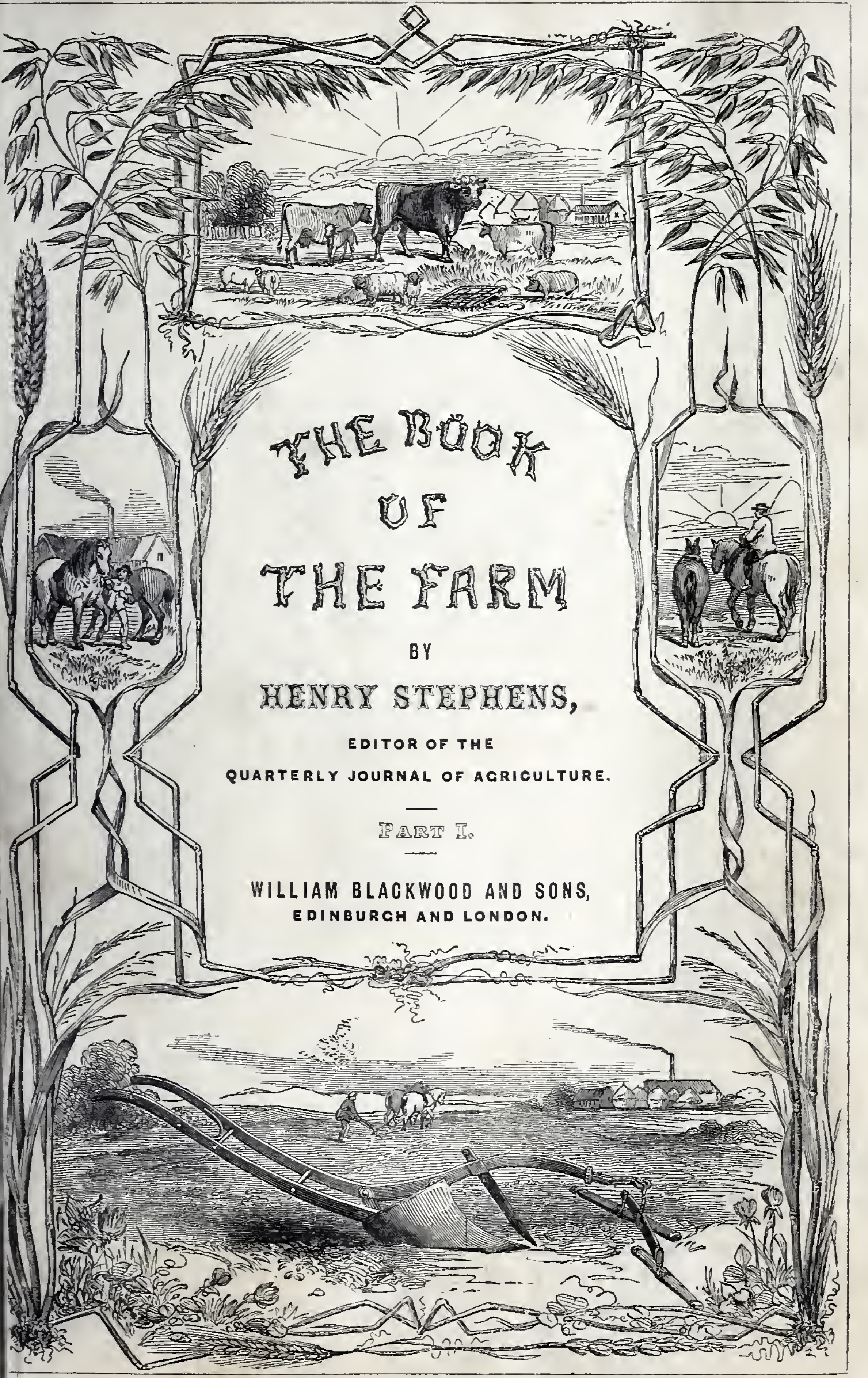

THE BOOK OF THE FARM

BY

HENRY STEPHENS,

EDITOR OF THE
QUARTERLY JOURNAL OF AGRICULTURE.

PART I.

WILLIAM BLACKWOOD AND SONS,
EDINBURGH AND LONDON.

PRICE FOUR SHILLINGS.

PLAN OF THE WORK.

THE BOOK OF THE FARM is intended as a Guide to those who wish to learn Husbandry with the purpose of becoming *practical* Farmers. Its Author is of opinion, that a work having that decided object in view, is yet wanting in the agricultural literature of this country; and to supply this desideratum is his aim, all his inferences having been drawn from *practical* experience. The better to accomplish this, he has divided it into three portions.

In the *first*, the Pupil is shown the difficulties which he has to encounter in acquiring a competent knowledge of Farming as a profession; and the most easy and effectual methods of overcoming these. Every field operation, as it comes round in season, is successively pointed out and explained to him; and his mind is thus prepared for a better understanding of the general import to be derived from an acquaintance with its minute and multiplied details.

The *second* portion details the various kinds of farming practised in this country; and points out that which the Author reckons the best for adoption under given circumstances. The operations of the recommended system are given from the beginning to the end of the agricultural year, together with instructions for the culture of the plants, and the treatment of the various animals usually found on a farm. To place these important particulars in the most intelligible form before the Agricultural Pupil, the Author has divided the entire labours of the farm—as they are actually done in practice—into *four great epochs*, each of which is begun and brought to a close, at its appropriate time, in one or more of the *Four Seasons:* the first beginning in Winter, which commences the agricultural year, and the last terminating in Autumn, when the various labours of the field are each brought to a termination. Instructions are given for the proper practical management of the various crops, and the live stock on a farm, during these seasonal periods of the year; and reasons are stated, explanations offered, and theories suggested, in order to show that the particular recommendations given are better than any other that can be followed. Practice and theory are thus presented together; but the suggestions and narratives regarding each are studiously kept separate.

By the adoption of this arrangement, no differences of views are allowed to interfere with the multifarious but distinct subject-matter of farm management; and it has this advantage over every other, that it presents all the successive operations in the order that they actually occur in practice

CONTINUED AT PAGE 3 OF COVER.

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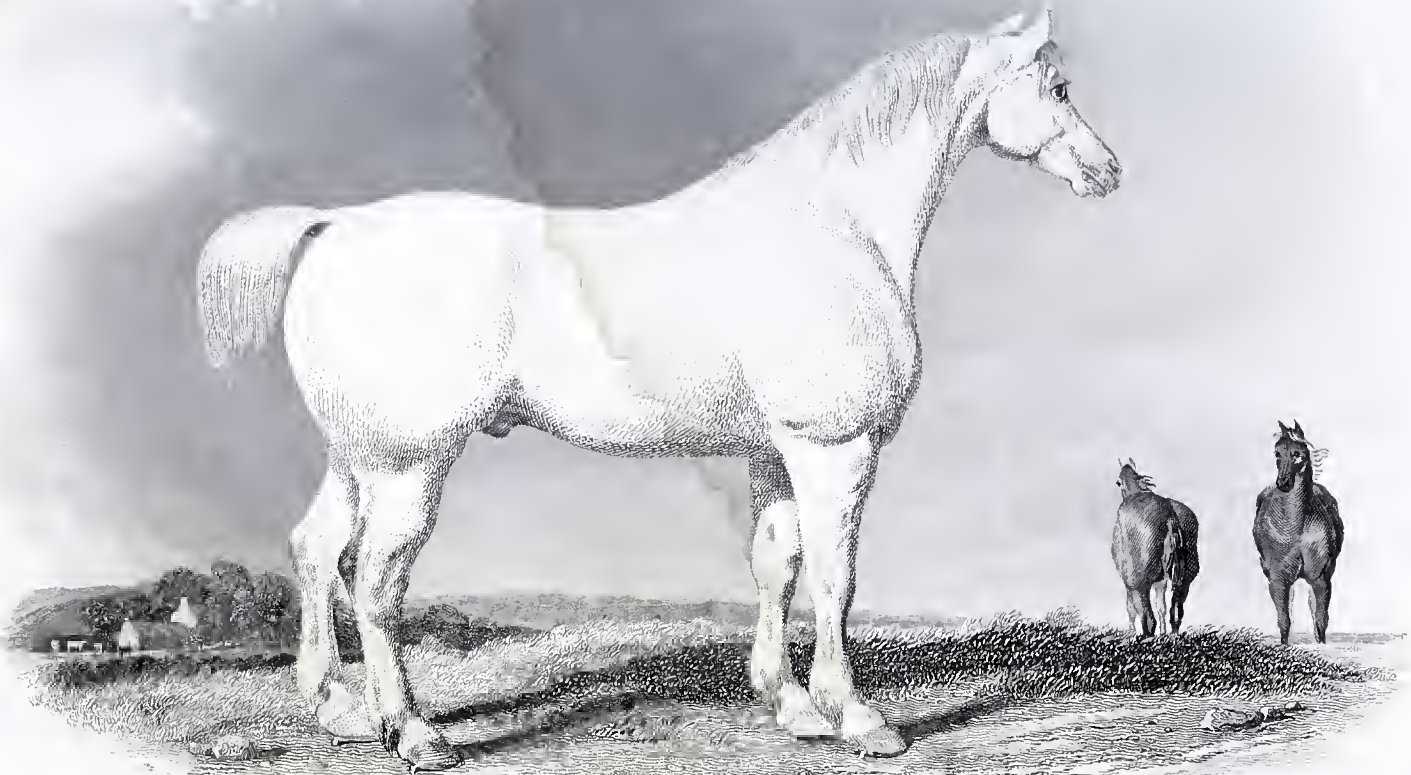

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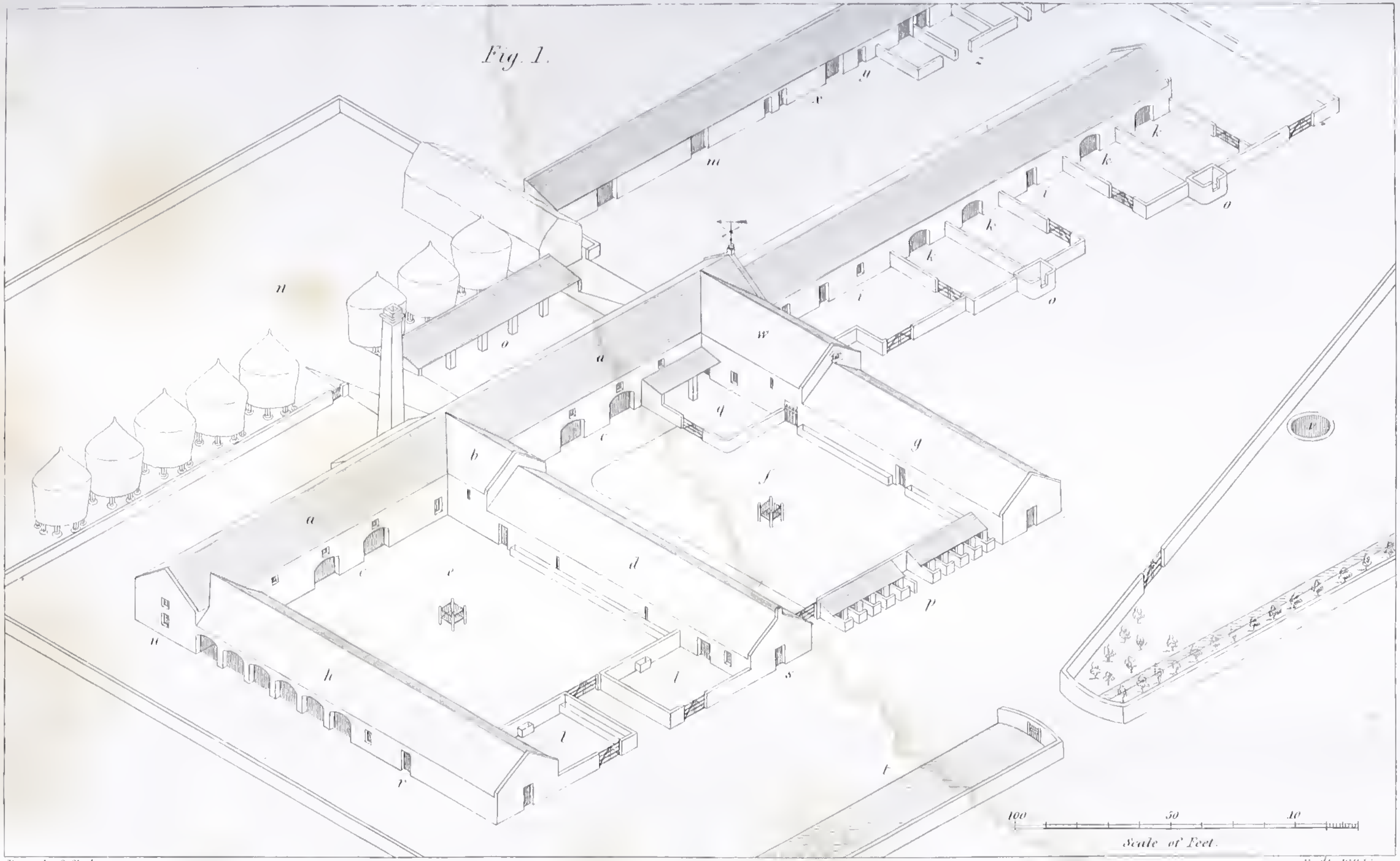
Fig. 1.



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ISOMETRICAL VIEW OF AN EXISTING STEADING.

PLATE II.

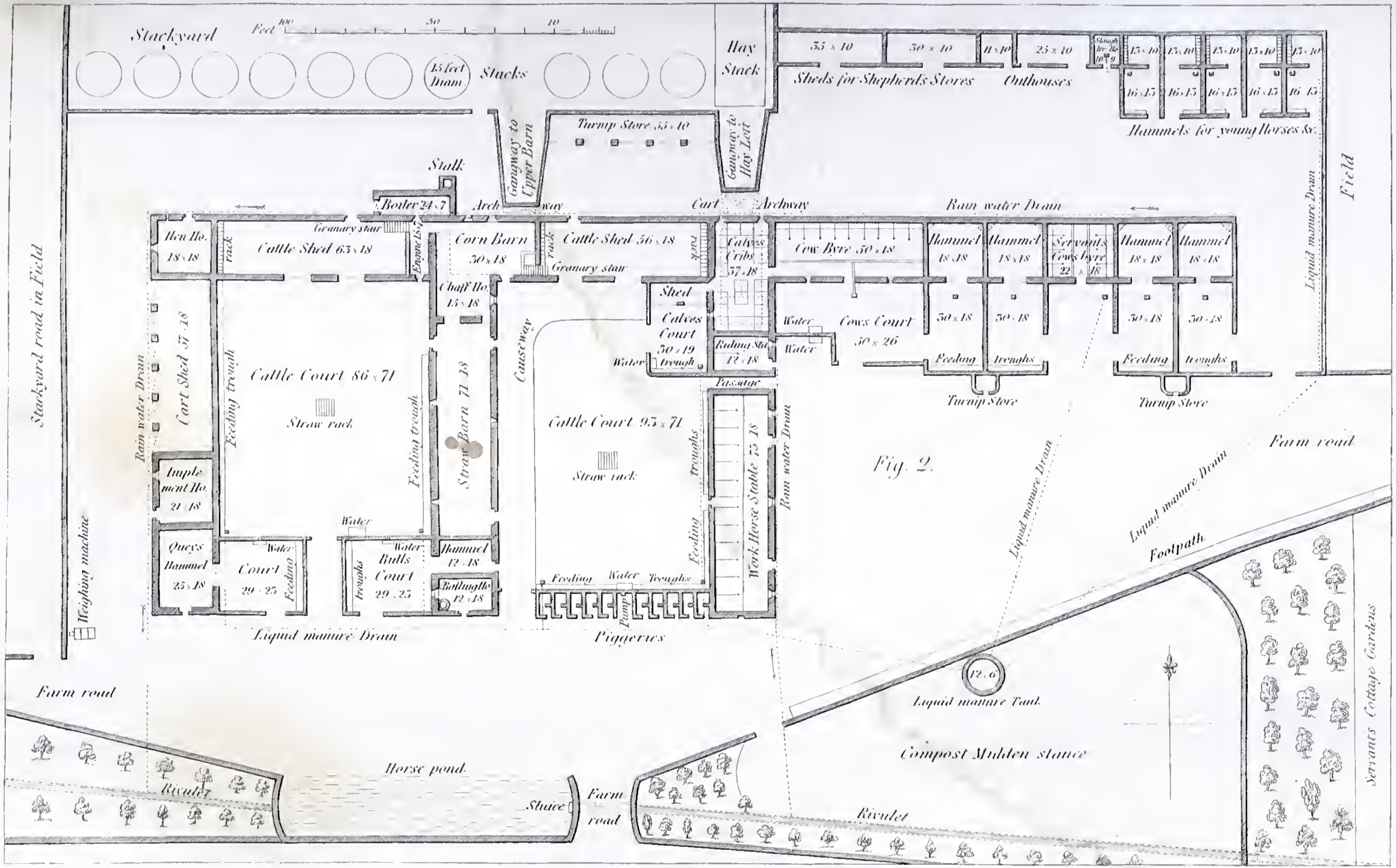

Fig. 2.

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GROUND PLAN OF AN EXISTING STEADING.

THE

BOOK OF THE FARM.

1. OF THE DIFFICULTIES WHICH THE YOUNG FARMER HAS TO ENCOUNTER AT THE OUTSET OF LEARNING PRACTICAL HUSBANDRY.

> " One, but painted thus,
> Would be interpreted a thing perplex'd
> Beyond self-explication." CYMBELINE.

The young farmer, left to his own guidance, when beginning to learn his profession, encounters many perplexing difficulties. The difficulty which at first most prominently obtrudes itself on his notice, consists in the *distribution* of the labour of the farm ; and it presents itself, in this way :—He observes the teams employed one day in one field, at one kind of work ; and, perhaps, the next day in another field, at a different sort of work. He observes the persons, employed as field-workers, assisting the teams one day ; and in the next, perhaps, working by themselves in another field or elsewhere. He observes those changes with attention, considers of their utility, but cannot discover the reasons for making so very varied arrangements ; not because he entertains the least doubt of their propriety, but, being as yet uninitiated in the art of farming, he cannot foresee the purpose for which those labours are performed. The reason why he cannot at once foresee this, is, that in all cases, excepting at the finishing operations, the end is unattained at the time of his observation.

The next difficulty the young farmer encounters is in the *variety* of the labours performed. He not only sees various arrangements made to do the same sort of work, but various kinds of work. He discovers this difference on examining more closely into the nature of the work he sees performing. He observes one day the horses at work in the plough in one field, moving in a direction quite opposite, in regard to the ridges, to what they were in the plough in another field. On another day he observes the horses at work with quite a different implement from the plough. The field-workers, he perceives, have laid aside the implement with which they were working, and are performing the labour engaged in with the hand. He cannot comprehend why one sort of work should be prosecuted one day, and quite a different sort of work the next. This difficulty is inexplicable for the same reason why he could not overcome the former one ; because he cannot foresee the end for which those varieties of work are performed. No doubt he is aware, that every kind and variety of work which are performed on a farm, are preparatives to the attainment of certain crops ; but what portion of any work is intended as a certain part of the preparation for a particular crop, is a knowledge which he cannot acquire by intuition. Every preparatory work is thus perplexing to the young farmer.

Field work being thus chiefly *anticipatory*, is the circumstance which renders its object so perplexing to the learner. He cannot, possibly, perceive the connection between preparatory labours and their ultimate ends; and, yet, until he learn to appreciate their necessary connection, he will remain incapable of managing a farm. It is in the exercise of this faculty of anticipation or foresight that the experienced and careful farmer is contradistinguished from the ignorant and careless. Indeed, let the experience of farming be ever so extensive, or, in other words, let the knowledge of minutiæ be ever so intimate, unless the farmer use his experience by foresight, he will never be enabled to conduct a farm aright. Both foresight and experience are acquired by observation, though the former is matured by reflection. Observation is open to all farmers, but all do not profit by it. Every farmer may acquire in time sufficient *experience* to conduct a farm in a passable manner ; but many farmers never acquire *foresight*, because they never reflect, and therefore cannot make their experience tell to the most advantage. Conducting a farm by foresight is thus a higher acquirement than the most intimate knowledge of the minutiæ of labour. Foresight cannot be exercised without the assistance of experience; though the latter may exist independently of the former. As the elements of every art must first be acquired by observation, a knowledge of the minutiæ of labour should be the first subject for acquirement by the young farmer. By carefully tracing the connection betwixt combined operations and their ultimate ends, he will acquire foresight.

The necessity of possessing foresight in arranging the minutiæ of labour, before the young farmer can with confidence undertake the direction of a farm, renders *farming* more difficult of acquirement, and a longer time of being acquired, than most other arts. This statement may appear incredible to those who have been accustomed to hear of farming being easily and soon learned by the meanest capacity. No doubt it may be acquired in time, to a certain degree, by all who are capable of improvement by observation and experience; but, nevertheless, the ultimate ends for which the various kinds of field-work are prosecuted, are involved in obscurity to every learner. In most other arts no great space usually elapses between the commencement and completion of the piece of work, and the piece is worked at until finished. The beginner can thus soon perceive the connection between the minutest portion of the work in which he is engaged, and the object for which it is intended. There is in this no obscurity to perplex his mind. He is purposely led, by degrees, from the simplest to the most complicated parts of his art, so that his mind is not bewildered at the outset by participating in a multiplicity of works at one time. He thus begins to acquire true experience from the outset.

The young farmer has no such advantages in his apprenticeship. There is no simple easy work, or one object only to engage his attention at first. On the contrary, many minutiæ connected with the various works in progress, claim his attention at one and the same time, and if the requisite attention to any one of them be neglected for the time, no other opportunity for observing it can occur for a twelvemonth. It is a misfortune to the young farmer, in such circumstances, to be thrown back in his progress by a trifling neglect. He cannot make up his leeway until after the revolution of a year. And though ever so attentive he cannot possibly learn to anticipate operations in a shorter time, and therefore cannot possibly understand the drift of a single operation in the first year of his apprenticeship. The first year is generally spent almost unprofitably, and certainly unsatisfactorily to an inquisitive mind. But attentive observation during the first year, will enable him, in the second, to anticipate the successive operations ere they arrive, and arrange every minutia of labour as it is required. Many of the events of the first year, which had left no adequate impression of their importance on his memory, crowd upon his observation in the second, as essential components of recognised operations. A familiar recognition of events, tends, in a rapid degree, to enlarge the sphere of experience, and to inspire confidence in one's own judgment; and this quality greatly facilitates the acquisition of foresight.

Let it not be imagined by those who have never passed through the perplexing ordeals incident to the first year of farming, that I have described them in strong colours, in order to induce to the belief, that farming is an art more difficult of attainment than it really is. So far is this from being the case, I may safely appeal to the experience of every person who had attained manhood before beginning to learn farming, whether I have not truly depicted his own condition at the outset of his professional career. So that every young man learning farming must expect to meet with those difficulties.

2. OF THE MEANS OF OVERCOMING THOSE DIFFICULTIES.

> "We can clear these ambiguities."
>
> ROMEO AND JULIET.

Experience undoubtedly dissipates doubt, and removes perplexity; but experience, though a sure and a safe, is a slow teacher. A whole year must revolve ere the entire labours of a farm can be exhibited in the field, and the young farmer satisfactorily understand what he is about; and a whole year is too much time for most young men to *sacrifice*. Could the young farmer find a monitor to explain to him, during the first year of his apprenticeship, the purpose for which every operation on a farm is performed,—foretell to him the results which every operation is intended to effect,—and indicate to him the relative progress which all the operations should make, from time to time, towards the attainment of their various ends, he would thereby acquire a far greater quantity of professional information, and have greater confidence in its accuracy, than he could possibly obtain for himself in that anxious period of his novitiate. Such a monitor would best be an experienced and intelligent farmer, were he duly attentive to his pupil. Farmers, however, can scarcely bestow so much attention as would be desired by pupils at all times; because the lapses of time occasioned by necessary engagements, in the fulfilment of which farmers are sometimes obliged to leave home, produce inattention on the part of the farmer; and inattention and absence combined constitute sad interruptions to tuition, and cannot always be avoided by the most pains-taking farmer. But a *book* might be made an efficient assistant-monitor. If expressly written for the purpose, it might not only corroborate what the farmer inculcated, but serve as a substitute in his temporary absence. In this way tuition might proceed uninterruptedly; and the pupil never want a monitor upon whom he could confidently rely. Were a book purposely so arranged put into the hands of young farmers so circumstanced, the usual deprecations against recommending the acquirement of practical farming from books alone, would not here apply. I would give no such counsel to any young farmer. Because books on farming, to be really serviceable to the learner, ought not to constitute the arena on which to study farming—the field being the best place for perceiving the fitness of labour to the purposes it is designed to attain—but as monitors for indicating the best modes of management, and shewing the way of learning those modes most easily. *By these, the practice of experienced farmers might be communicated and recommended to beginners. By consulting those which had been purposely written for their guidance, while they themselves were carefully observing the daily operations of the farm, the import of labours,—which are often intricate, always protracted over considerable portions of time, and necessarily separated from each other,—would be acquired in a much shorter time than if left to be discovered by the sagacity of beginners.*

It is requisite to explain, that by the phrase "*young farmer*," I mean the young man, who, having finished his scholastic and academical education, directs his attention, for the first time, to the acquirement of practical farming; or who, though born on a farm, having spent the greater part of his life at school, determines, at length, on following his father's profession. For the latter class of young men, tuition in farming, and information from books, are as requisite as for the former. Those who have constantly seen farming from infancy, can never be said to have been young farmers, for, by the time they are fit to act for themselves, they are proficients in farming. Having myself, for a time, been placed precisely in the position of the first description of young men, I can bear sincere testimony to the truth of the difficulties I have described as having to be encountered in the first year of apprenticeship. I felt that a guide-book would have been an invaluable monitor to me, but none such existed at the time. No doubt it is quite reasonable to expect of the farmer, ability to instruct the pupils committed to his charge in a competent manner. This is certainly his duty, which, if rightly performed, no guide-book would be required by pupils; but very few farmers who receive pupils, undertake the onerous task of instruction. Practical farming they leave the pupils to acquire for themselves in the fields, by imperfect observation and slow experience, as they themselves had previously done,—theoretical knowledge, very few, if any, are competent to impart. The pupils, being thus very much left to their own application, can scarcely avoid being beset with difficulties, and losing much time. At same time it must be acknowledged, that the practice gained by slow experience is, in the end, the most valuable and enduring. Still a book on farming, expressly written to suit his circumstances, might be a valuable instructor to the young farmer; it might guard him against the difficulties which learners are apt to encounter; and it would recompense him for loss of time, by imparting sound professional information.

Such a book, to be really a useful instructor and correct guide, should, in my estimation, possess these necessary qualifications. Its principal matter should consist of a clear narrative of all the labours of the farm, as they occur in succession; and it should give the reasons fully for which each piece of work is undertaken. While the principal operations are narrated in this way, the precise method of executing every species of work, whether manual or implemental, should be minutely detailed. The construction of the various implements by which work is performed,—the mode of using them,—the accidents to which each is liable,—should be circumstantially described. A seasonable narrative of the principal operations will shew the young farmer, that farming is really a systematic business, having a definite object in view, and possessing the means of attaining it. The reasons for doing every piece of work in one way, rather than another, will convince him that farming is an art founded on rational and known principles. A description of the implements, and of the method of using them, will give him a closer insight into the nature and fitness of field-work for attaining its end, than by any other means. A perusal of these narratives, all having a common object, will impart a more comprehensive and clearer view of the management of a farm in a given time, than he could acquire by himself from witnessing ever so many isolated operations. The influence of the seasons on all the labours of the field is another consideration which should be attended to in such a book. In preparing the ground, and during the growth of the crops, the labour appropriated to each kind of crop terminates for a time, and is not resumed until a fit season arrive. These periodical cessations from labour form natural epochs in the progress of the crops towards maturity, and afford convenient opportunities for performing the work peculiarly appropriate to each epoch; and, since every operation of the farm is made to conform with its season, these epochs correspond exactly with the *natural* seasons of the year. I say with the *natural* seasons, in contradistinction to the common yearly seasons, which are entirely conventional. This necessary and opportune agreement between labour and the natural seasons, induces a corresponding division of the labours of the farm into four great portions, or *seasons*, as they are usually termed. Labour should therefore be described with particular reference to its appropriate season.

3. OF THE KIND OF INFORMATION TO BE FOUND IN EXISTENT WORKS ON AGRICULTURE.

> "Tire the hearer with a book of words."
>
> MUCH ADO ABOUT NOTHING.

Unless the business of a farm be treated in books somewhat in the manner thus described, I consider it impossible for a young farmer to derive from them the requisite information for conducting a farm, even though he should be constantly resident upon it. By even the most careful perusal of books, which relate methods of cultivating crops and treating live stock in the most general terms and in detached sections having no relative connection with each other, the young farmer will never, in my opinion, understand how to apportion labour, and modify its application to the raising of crops and rearing of live-stock, in accordance with the nature of the season. He will never learn to know by perusing a narrative couched in the most general terms, when an operation is really well performed; because, to be able to judge of the quality of work, all its minutiæ ought previously to have been fully and carefully detailed to him. Narratives couched in general terms, to the exclusion of essential minutiæ, will never impart that precision of ideas which the mind should possess in conducting any piece of field work; and without precision of ideas in regard to labour, no man will ever be able to conduct a farm aright. But to be told how to conduct a farm aright, is the chief motive of the young farmer for consulting a book at all.

Now, on examining works of any pretensions which have, for years past, been written on practical agriculture, none will be found to have been written and arranged on the principles I have recommended, and much less for the special benefit of beginners in farming. All are so arranged as to constitute books of reference for experienced, rather than as guides for young farmers. Yet, how few of the former will condescend to *consult* agricultural works! The aversion of experienced farmers to consult books on agriculture has long been proverbial. No doubt, this aversion may be explained; but whether the explanation is to be found in a general indifference to book-farming, or in the quality of the books themselves, or in both circumstances combined, it is not easy to determine. The aversion, however, appears to be felt more towards systematic than periodical works on agriculture.

The latter class receives favour, because, possibly, they may contain something that is not generally known, and their information bears the character of freshness. As to young farmers, if they cannot find books suited to their particular state of knowledge, they have no alternative but to peruse those that are extant.

For the sake of the young farmer, the usual contents of agricultural books require further consideration. Let any systematic work on practical agriculture be examined, and it will be found to contain an arrangement of the various particulars of farming, somewhat in this order. The soil and the various methods of working it are first described. The implements are then most probably particularised, or their description deferred to a later portion of the work. The methods of raising and securing the different kinds of crops are then detailed. And the treatment of live-stock is delayed to the last. We suppose that no satisfactory reasons can be given for adopting this particular arrangement of subjects. It is perhaps considered a *simple* arrangement, because it proceeds from what is considered the elementary process of preparing the soil, to the more complicated process of cultivating the plants for which the soil has been prepared. But the simplicity of the arrangement, I apprehend, is to be found rather in what is assumed than what is apparent; for ploughing land is not a more simple process, or more elementary, than sowing seed. Indeed, some sorts of ploughing require far greater dexterity and ingenuity in the performance than any process connected with the production of crops. Perhaps it is considered a *natural* arrangement, because the ground is first prepared, and the crop is then sown. The ground, it is true, must be partially, if not wholly, prepared before the crop be put into it; but, in the cultivation of the summer crops, much of the labour bestowed on the land is performed whilst the crops are in a rapid progress towards maturity.

Although the seasons visibly influence the operations and products of the farm, systematic works on agriculture scarcely disclose the subdivision of the year into seasons, much less the very different operations performed in different seasons, and still less the difference of character of the same season in different years. For all that is given in them by way of advice, every operation may as well be performed in one season as in another. No doubt, reference is made, and cannot altogether be avoided being made, to the season in which the piece of work described should be performed; but the reference seems to allude to the season more as an accidental concomitant, than as constituting the sole influential power that regulates the order of time in which the work should be performed. The allusion to the season, in short, only forms an isolated hint, which, being singly repeated in a number of places, it is impossible for the reader to keep in mind the particular operation that should be performed in its own season. This apparent neglect of the great influential power which regulates all farm business, constitutes an insuperable objection to describing, in an uninterrupted narrative, a piece of work which is performed at intervals. Such a dissertation might bewilder the reader on its perusal, but could not satisfy the mind of the young inquiring farmer.

But the minuter arrangements in the books I am remarking on, are fully more objectionable than the general. The entire process usually adopted for working the land for a particular crop, is described in an uninterrupted narrative, before a description of the nature of the crop is given for which the soil is preparing; and, in consequence, before the connection between the preparation and the crop can be understood by the young farmer. This is not the usual procedure on farms, and cannot therefore be accounted natural; and it certainly tends to mislead the beginner. The usual practice is, that the land destined for any particular crop, is prepared to a certain degree, at stated times, in accordance with the natural seasons, and between those times many operations intervene which bear no relation to that particular crop. Every operation thus occupies a portion of time, intermittent in its season, and cannot truly be described in a continued dissertation. The finishing operation of every crop is always deferred until the appropriate season.

The descriptions of implements are very unsatisfactory, and their construction, for the most part, is very imperfectly represented. None trace their action from the first start to the entire completion of the work. Implements of husbandry having, only a few years ago, been made in the rudest manner, their actions were necessarily imperfect, and their absolute weight a serious drag on the draught. They are now constructed on true principles of mechanical science,—are light in motion, perfect in action, and elegant in form. It is remarkable that a correct description of improved implements has not ere this been undertaken by some skilful machinist.

Some works treat first of the science of agriculture, and then of the practice, as if the science of the art had been ascertained by studying abundance of facts derived from practice; or, as if its science already possesses such a superiority as to be allowed the precedence of practice. Others make science follow practice, as if the science had been derived from the practice described; whereas what is offered as science, is generally presented in isolated speculations, volunteered chiefly by theorists unacquainted with the practice of agriculture. Some authors theorise on agricultural subjects from as slight a foundation of facts, as in the experimental sciences, although they profess to give no preference to science over practice. Theorising writers, however, sometimes throw out hints which, when improved by more practical experimenters, really lead to useful results; but whatever may be the origin of the hints of theorists, the ability to give a convincing and philosophical reason for every operation in husbandry, is an accomplishment which every young farmer should endeavour to attain. Efforts to discover reasons for practice, derived from principles applicable alike to science and good husbandry, is a healthful exercise of the mind, and tend to render it capable of accommodating practice to existing circumstances. Conformity of practice with the season, exhibits in the farmer superior ability for conducting farming operations: like the experienced mariner, who renders every change in the gale subservient to the safety of his ship; navigation itself, not being more dependent on weather than is farming. By pursuing a course of observation and investigation such as this, the mind of the young farmer will soon become scientifically enlightened; but books on farming usually afford no assistance in pursuing such a course of study.

The treatment of live-stock is usually deferred to the conclusion in works on agriculture, as if it were either the most important, or the most complicated occupation, of the farm. Breeding for the improvement of a particular race of animals, and judicious crossing betwixt two fixed races, are indeed occupations which tax the judgment severely; but the ordinary treatment of live-stock is as easily managed as most of the operations of the field. The complete separation, moreover, made in books betwixt live-stock and field-operations, is apt to impress the mind of the inexperienced reader, that no necessary connection subsists betwixt stock and crop, whereas neither can be treated with advantage either to the farmer or themselves, unless both are attended to simultaneously.

From what I have stated regarding the arrangement of the subjects in systematic works on agriculture, it will be observed that they are better adapted for reference than tuition. They form a sort of dictionary or cyclopedia, in which different subjects are treated independently of each other, under different heads, though they may not be placed in alphabetical order. Being strictly works of reference, they may be consulted at any time; and are only valuable as such, in proportion to the accuracy of the information they contain: and being such, they are unfitted to impart agricultural knowledge suited to *beginners;* because, 1*st*, operations are not described in the order in which they occur on the farm;

2d, the descriptions omit many of the minutiæ of management, and yet constant attention to these constitutes an essential characteristic of a good farmer; *3d*, they contain no precautionary warnings against the probability of failure in operations from various incidental causes, which ought to be anticipated, and attempted to be shunned; and, *4th*, they afford no idea of the mode of carrying on various operations simultaneously in the different departments of management. Such works, therefore, impart no notion of *how* to set about to conduct a farm; and yet, without this essential information, to obtain which the earnest young farmer toils incessantly, they can render him no assistance as guides. Indeed, the authors of such works do not profess to be teachers of young farmers.

Experience has made me well acquainted with the nature of the difficulties tyros in agriculture have to contend with; and I clearly see that the books on farming extant, are incompetent to assist them in overcoming those difficulties. I consider it, therefore, very desirable that a work should be written for the express purpose of presenting facilities to young farmers, in the acquirement of their profession. This opinion I have entertained for many years, and see no cause to change it for all the works on agriculture that have been published of late years. To me it is matter of surprise that such a work has never yet been written by any of the prominent writers on agriculture in this prolific age of books, when assistance in the acquirement of learning is proffered in so many shapes to the youths of all classes. In most other branches of art, there is no want of facilities in books for acquiring their elementary principles and practice. On the kindred art of gardening, in particular, every possible variety of publication exists, from the ponderous folio to the tiny duodecimo, containing all the minutiæ of practice, and the elucidation of principles. It is difficult to account for the want of solicitude shewn by agricultural writers, for the early advancement of the young farmer. Perhaps many of them have never experienced the irksome difficulties of acquiring a practical knowledge of agriculture, and therefore cannot extend their sympathies to those who have;—perhaps the exhibition of an intimate acquaintance with the minutiæ of farming appears too trivial an accomplishment to arrest the attention of general writers;—perhaps they think when a young man begins to farm, it is sufficient for him to have a steward in whose skill he can confide;—perhaps the tuition of young farmers is beneath their dignity, and they would rather aspire to the higher object of instructing experienced men;—or perhaps they have never condescended to trouble themselves with practical farming, which, to judge of their lucubrations by the sterlingness of their practical worth, many of them, I dare say, never have.

4. OF THE CONSTRUCTION OF "THE BOOK OF THE FARM."

> "A book? O rare one!
> Be not as is our fangled world, a garment
> Nobler than that it covers: let thy effects
> So follow, to be most unlike our courtiers,
> As good as promise."
>
> CYMBELINE.

A book for the special purpose of instructing young farmers, such as it should be, and such as they are entitled to expect from the hands of experienced agriculturists, is yet a desideratum in the agricultural literature of this country. I am disposed to question the ability of any one man to write such a work; as its accomplishment would require a rare combination of qualities. The writer would require, as a primary qualification, to be a highly experienced agriculturist able to indite lucid instructions for conducting a farm. He should also be a clear-headed mechanician, to describe with minute distinctness the principles and construction of agricultural implements. He should, moreover, be an accomplished man of science, to explain to conviction the rationale of every operation. Onerous as the task thus appears, I shall, nevertheless, attempt to write such a book. With adequate assistance I trust, I shall be able to overcome at least the practical difficulties of the undertaking; and as to the scientific part, men of science have not yet brought science to bear upon agriculture in so satisfactory a manner as to justify them in contemning the rational explanations given of the various operations by practical men. Could I but succeed in *arranging* the various operations as they successively and actually occur on a farm, in so lucid a manner, as that any young farmer might comprehend the exact purport of each piece of work, as it developed itself in the field, I should certainly do him essential service. In accomplishing this, it is scarcely possible to invest, with sufficiently attractive interest, the descriptions of the minute details of the various operations, so that their aptitude to the purpose intended may be appreciated. Careful attention to these details, in themselves I own irksome, will the sooner enable the young farmer to understand thoroughly the connection of successive operations, and by the understanding of which he will be forewarned of the approach, and be able to ascertain the import, of the particular end for which they are preparatory. Besides shewing by anticipation the successive operations as they arrive, could I also give clear descriptions of the labour performed for each crop, as it is carried on *simultaneously* on a farm, I should achieve a still greater service for the young farmer. He would then clearly comprehend a difficult department of his art.

To accomplish these ends, I purpose to arrange the matter in the following manner, and for the following reasons. The entire business of a farm necessarily occupies a year; but that year embraces in some years more, and in others less, than twelve months. The agricultural year, moreover, both in its commencement and termination, does not correspond with that of the calendar; and those periods are determined in this way. The beginning and ending of every agricultural year are entirely dependent on the duration of the life of cultivated vegetables which constitute the chief product of the farm. In the temperate regions of the globe, vegetable life becomes dormant, or extinct, according as the vegetable is perennial or annual, at the beginning of winter. The beginning of winter is therefore chosen, in the temperate zones, to commence the agricultural year, and, of course, the labours of the farm; and when winter again approaches, the labours of the field have performed their annual revolution. The same sort of work is performed year after year. To understand those labours throughout the year is the chief aim of the young farmer; and to describe them to him satisfactorily is the principal object of this book.

Two modes of describing farm-business may be adopted. One is to arrange it under different heads, and describe all similar operations under the same head, as has hitherto been done in systematic works on agriculture. The other mode is to describe the operations as they *actually occur, singly, in succession*, as is to be done in this work. Both methods describe the general farm business, and both may be consulted for any particular part of the business. But how the relative position of any particular part of the business stands in regard to and influences any other, can only be shewn by the latter method, and it does so at a glance of the eye. Moreover, as some parts of farm business commence, and others terminate, at one or other period of the year, the latter method can clearly indicate what the other cannot so well do, in which period any particular operation is commenced, continued, or terminated; and it gives the details of each operation much more minutely than the other method.

The agricultural year, like the common year, is distinctly and conveniently divided into seasons, which regulate all farm work. I have given the seasons as full an influence over the arrangements of the matter in this book as they really possess over the business-matter of the farm. The whole business-matter is divided into four parts, each bearing the name of the season that influences the operations that are performed in it. By this arrangement every operation, whether requiring longer or shorter time for completion, is described as it takes its turn in the fields. The work that occupies only a short time to begin and complete, in any one season, is described in a single narrative. Very few of the operations of a farm, however, are begun and completed in one of the seasons, some extending over the whole four, and most into two or three. Any piece of work that extends over almost all the seasons, can nevertheless be described with great accuracy; for although, in its progress towards completion, it may altogether occupy an extended range of time, each season imposes a peculiar kind of operation towards the advancement of the work; which peculiar operation ceases, and a different kind is entered upon at the season which concludes the work. These cessations of labour, connected with the same work which extends over several seasons, are thus not mere conveniences, but necessary and temporary finishings of work, which it would be improper to resume but at a subsequent and appropriate season. In this way all the more extensive pieces of work are gradually advanced, in progressive steps, season after season, until their completion; while the smaller are concurrently brought onwards and completed, each in its proper season.

Before proceeding further, let me guard the young farmer against imbibing a misconception regarding the *length* of the seasons. In the year of the calendar, each season extends over a period of three calendar months; and the same three months every year compose the same season, whatsoever may be the nature of the weather. Every season of the calendar is thus of the same length. The seasons of the agricultural year, though bearing the same names as those of the calendar, are, on the other hand, not of the same length every year, but their duration is regulated by the state of the weather. The agricultural seasons have characteristic signs to distinguish them. The spring revives the dormant powers of vegetables; the summer enlarges their growth; the autumn develops the means of reproduction; and the winter puts a stop to vegetable energy. In the year of the calendar these characteristics are assumed to last just three months in each season, but in the agricultural year, notwithstanding that the characteristics of one season extend over, or are contracted within three months, still that season bears its proper name, whether it encroaches on or is encroached upon by another season. The spring, for example, may be encroached on by the protraction of winter on the one hand, and the earliness of summer on the other; a case in which results both a late and short spring,—a state of spring which creates very bustling work to the farmer. So with the rest of the seasons. This elastic property in the agricultural seasons contradistinguishes them from the seasons of the calendar which possess no elasticity. The commencement, continuance, and termination of field work, being therefore entirely dependent on the seasons of the agricultural year, and those seasons, in their turn, being as dependent on the weather, it follows that field operations are entirely dependent on the state of the weather, and not on the conventional seasons of the calendar. Whether an agricultural season be long or short, the work that properly belongs to it *must* be finished in it whilst it lasts. If it be of sufficient length, the work to be performed, admitting of a considerable latitude of time, may be well finished, and if not so finished, the crop runs the risk of failure. Should any season happen to be shortened by the weather, by the preceding season encroaching upon it, the work should be so far advanced during the preceding prolonged season, that, when the proper season for its completion arrives, as arrive it will, the finishing may be accomplished before its expiry. Should any season be curtailed by the earliness of the succeeding one, and the weather improve, as in the case of summer appearing before its time, no apprehension need be entertained of accomplishing the finishing work in a satisfactory manner; but should the weather prove worse, as in the premature approach of winter upon autumn, then extraordinary exertions are required to avert the disastrous consequences of winter weather upon the crops. The unusual protraction of any of the seasons in which a work should be completed is attended with no risk, except that too frequently from the consciousness of having plenty of time to complete the work, unnecessary delay is permitted, until the succeeding season unexpectedly makes its appearance. In such cases procrastination is truly the thief of time. During the protraction of a season, much time is often wasted in waiting for the arrival of the succeeding one, in which a particular work is most properly finished; but in a contracted season, a great part of the work is hurriedly gone through, and of course slovenly performed. The most perfect field-work is performed when the agricultural and conventional seasons happen to coincide in duration.

The greatest difficulty which the farmer experiences when first assuming the management of a farm is in distributing and adjusting labour. To accomplish this distribution and adjustment correctly, in reference to the work, and with ease as regards the labourer, a thorough knowledge is requisite of the quantity of work that can be performed in a given time by all the instruments of labour, animal and mechanical, usually employed. It is the duty of the young farmer to acquire this knowledge with all diligence and dispatch; for a correct *distribution* of the instruments of labour enables the work to be performed in the most perfect manner in regard to the soil,—with the smallest exertion as regards physical force,—and with the greatest celerity in regard to time; and, in the *adjustment* of those instruments, every one should just perform its own share of work. These essential particulars I shall point out, in their connection with the work in hand. In descanting on the distribution of labour, I shall incur the hazard of being prolix rather than superficial. The general reader may dislike the perusal of minute details; but the ardent student will receive with thankfulness the minutest portion of instruction, especially as he can only otherwise acquire this kind of instruction by long experience. The distribution and adjustment of labour is a branch of farm management that has been entirely overlooked by every writer on systematic agriculture.

Constant attention on the part of the young farmer to the minutiæ of labour evinces in him that sort of acuteness which perceives the quickest mode of acquiring his profession. The distribution of the larger pieces of work may proceed satisfactorily enough under the skill of ordinary work-people; but the minuter can *best* be adjusted by the master or steward. The larger operations would always be left in a coarse state, were the smaller not to follow, and finish them off neatly. There are many minor operations, unconnected with greater, which should be skilfully performed for the sake of their own results; and they should be so arranged as to be performed with neatness and dispatch. Many of them are frequently performed concurrently with the larger operations; and to avoid confusion both their concurrent labours should harmonize. Many of the minuter operations are confined to the tending of live-stock, and the various works performed about the farmstead. Attention to minutiæ, constituting the chief difference betwixt the neat and careless farmer, I have bestowed due consideration on them. They form another particular which has been too much overlooked by systematic writers on agriculture.

Implements of husbandry may be considered the right hand of the farmer; because, without their aid, he could not display the *skill* of his art. Modern mechanical skill has effected much by the improvement of old, and the invention of new implements. Modifications of construction and unusual combinations of parts are frequently attempted by mechanics; and though many such attempts issue in failure, they nevertheless tend to divulge new combinations of mechanical action. It is desirable that all mechanists of implements should understand practical agriculture, and all farmers study the principles of mechanics and the construction of machines, so that their conjoined judgment and skill might be exercised in testing the practical utility of implements. When unacquainted with farming, mechanists are apt to construct implements that are obviously unsuited to the work they are intended to execute; but having been put together after repeated alterations, and, probably, at considerable expense, the makers endeavour to induce those farmers who are no adepts at mechanics to give them a trial. After some unsatisfactory trials they are thrown aside. Were farmers acquainted with the principles of mechanics, the discrimination which such knowledge would impart would, through them, form a barrier against the spread of implements of questionable utility, and only those find circulation which had been proved to be simple, strong, and efficient. It may be no easy matter to contrive implements possessing all those desirable qualities; but, as they are much exposed to the weather, and the ground upon which they have to act being ponderous and uncouth, it is necessary they should be of simple construction. Simplicity of construction, however, has its useful limits. Most farm operations being of themselves simple, should be performed with simple implements; and all the *primary* operations, which are simple, requiring considerable power, the implements executing them should also be *strong;* but operations that are complicated, though stationary, require to be performed with comparatively complicated machinery, which, being stationary, may be used without derangement. Operations that are both complicated and locomotive should be performed with implements producing complicated action by simple means, in order to avoid derangement of their constituent parts. This last is a difficult, if not impossible problem, to solve in practical mechanics. The common plough approaches more nearly to its practical solution than any other implement; yet that truly wonderful implement, executing difficult work by simple means, should yet be so modified in construction, as to permit the ploughman to wield it with greater ease. These considerations tend to shew, that the form and construction of implements of husbandry, and the circumstances in which they may be used, are still subjects affording ample scope upon which mechanical skill can exercise itself.

Implements have not received in works on agriculture that consideration which their importance demands. The figures of them have been made by draftsmen, who have evidently had no accurate conception of the functions of their constituent parts. The descriptions given of those constituent parts are generally meagre, and not unfrequently erroneous; and as to the best mode of using implements, and the accidents to which they are liable, one would never discover that there was any peculiarity in the one, or liability to the other. In order to avoid both these classes of errors, much care has been bestowed in this work in delineating the figures, and giving descriptions of all the implements requisite for conducting a farm.

To insure accuracy in these respects, I consider myself fortunate in having acquired the assistance of Mr James Slight, Curator of the Machines and Models in the Museum of the Highland and Agricultural Society of Scotland, whose high qualifications as a describer and maker of machines are duly appreciated in Scotland. His son George, yet a very young man, is a beautiful delineator of them, as the drawings of the cuts and engravings in this work amply testify. And having myself paid close attention to the applicability of most of the implements used in farm operations, I have undertaken to describe the mode of using them, to state the quantity of work which each should perform, the accidents to which each is liable, and the precautions which should be used to avoid accidents. With our united efforts, I have confidence of giving such an *exposé* of farm implements as will surpass every other work of the kind. We have the advantage of having the field to ourselves. To assist the right understanding of the implements, they are represented by figures. Wood-cuts placed in the letter-press is the most convenient, and perhaps the most satisfactory, mode of illustration; but as the essential constituent parts of complicated implements are too much hidden for such a mode of illustration, such implements are engraved on separate plates.

So much for the practical, and now for the scientific portion of the work. Agriculture may, perhaps, truly be considered one of the experimental sciences, as its principles are no doubt demonstrable by the test of experiment, although farmers have not yet been able to deduce principles from practice. It is remarkable, that very few scientific men have as yet been induced to subject agricultural practice to scientific research; and those of them who have devoted a portion of their time to the investigation of its principles have imparted little or no satisfactory information on the subject. This unfortunate result may probably have arisen from the circumstance, that agriculture has so intimate a relation to every physical science, that, until all those relations are first investigated, no sufficient data can be offered for a satisfactory scientific explanation of its practice. The difficulty of the investigation is, no doubt, much enhanced, by husbandry being usually pursued as a purely practical art, because the facility of thus pursuing it successfully renders practical men indifferent to science. They consider it unnecessary to burden their minds with scientific research, whilst practice is sufficient for their purpose. Could the man of practice, however, supply the man of science with a series of accurate observations on the leading operations of the farm, the principles of those operations might be much elucidated; but I conceive the greatest obstacle to the advancement of scientific agriculture is to be sought for in the unacquaintance of men of science with practical agriculture. Would the man of science become acquainted with practice, much greater advancement in scientific agriculture might be expected than if the practical man were to become a man of science, because men of science are best capable of conducting scientific research, and, being so qualified, could best understand the relation which their investigations bore to practice; and, until the relation betwixt principles and practice are well understood, scientific researches, though perhaps important in themselves, and interesting in their results, tend to no practical utility in agriculture. In short, until the facts of husbandry be acquired by practice, men of science will in vain endeavour to construct a satisfactory theory of agriculture on the principles of the inductive philosophy.

If this view of the present position of the science of agriculture be correct, it may be expected to remain in a state of quiescence until men of science become practical agriculturists, or, what would still prolong its state of dormancy, until farmers acquire scientific knowledge. It is a pity to damp the ardour of scientific pursuit where it is found to exist; but, from what I have observed of the scanty services science has hitherto conferred on agriculture, and knowing the almost helpless dependency of farming on the seasons, I am reluctantly impelled to the belief, that it is less in the power of science to benefit agriculture, than the sanguine expectations of many of its true friends would lead farmers to believe. It is wrong to doubt the power of science to assist agriculture materially; and it is possible, in this age of successful art, that an unexpected discovery in science may yet throw a flood of light on the path of the husbandman; but I am pretty sure, unless the man of science become also the practical husbandman, it will be difficult, if not impossible, for him to discover which department of the complicated art of husbandry is most accessible to the research of science.

Hitherto, as it appears to me, agriculture has derived little benefit from the sciences, notwithstanding its obvious connection with many of them. A short review of the relation which the physical sciences bear to agriculture will render this opinion more reasonable. In the first place, the action of the electric agency in the atmosphere and on vegetation is yet as little understood in a practical sense as in the days of Franklin and of Ellis. No doubt, the magnetic and electric influences are now nearly identified; but the mode of action of either, or of both, in producing and regulating atmospherical phenomena, is still ill understood; and, so long as obscurity exists in regard to the influence of their elementary principles, the history of atmospherical phenomena cannot advance, and the anticipations of atmospherical changes cannot be trusted.

Geologists, at first engaged in ascertaining the relative positions of the harder rocks composing the crust of the earth, have only of late years directed their attention to the investigation of the more recent deposits; but, even with these, they have afforded no assistance in the classification of natural soils and subsoils. They have never yet explained the origin of a surface-soil, almost always thin, though differing in thickness, over subsoils composed of different kinds of deposits. They have never yet ascertained the position and structure of subsoil deposits, so as to inform the farmer whether land would be most effectually drained with drains running parallel with, or at right angles to, the courses of valleys and rivers.

Systematic botany can only be useful to agriculture in describing the natural plants which are indigenous to different soils. Botanists have successfully shewn the intimate relation subsisting betwixt plants and the soils on which they grow; but much yet remains to be ascertained of the relation betwixt different soils and trees, and the effects of different subsoils on the same kind of tree. Planting cannot be pursued on fixed principles, if planters are unacquainted with this knowledge; and, until a fixed and generally received classification of soils and subsoils is determined on, it is impossible to comprehend, by description, what particular soil or soils the plants referred to affect.

Botanical physiology has developed many remarkable phenomena, and explained most of the important functions of plants,—investigations which tend to give a clearer insight into the growth of crops. In this department of science, too much discussion to be of benefit to agriculture has, as I conceive, been expended on what really constitutes the food of plants. Whether the food is taken up by the plant in a gaseous, a solid, or a liquid state, may in itself be a very interesting inquiry, but it tends to no utility in agriculture so long as no manures are supplied to crops in a gaseous or liquid state. All that can practically be done in supplying food to plants, is to observe the increased quantity of their secretions in a given condition from an increased given quantity of manure. Thus may the increased quantities of mucilage, farina, gluten, in the various cultivated plants, be observed. It is of little moment to the farmer whether the manure administered is taken up by the crops in a gaseous, liquid, or solid state, since all these secretions are elaborated from the same manure. The anatomical structure of plants, the situations, soils, and manures which crops affect, the secretions which they elaborate, and the prolificacy and value of their products, are the results that most interest the farmer ; and, if botanical physiologists desire to benefit agriculture, they must direct their attention to the emendation and increase of products. Again, the results from the cross impregnation of plants of the same kind, so as to produce valuable permanent varieties, may confer as valuable a boon on agriculture, as the successful crossings of different breeds of live-stock have already conferred by increasing their value. Many varieties of plants having their origin in this way have been brought into notice, and some are now established and extensively cultivated ; but most of the varieties in use have been obtained from casual impregnations effected by nature herself, and not by the efforts of man to obtain varieties possessing superior properties, as in the case of the domesticated animals. Thus botanical physiology might confer great benefit on agriculture, if its views were directed to increasing the prolificacy of valuable plants already in cultivation, and introducing others that would withstand the modes of culture and changes of climate incidental to this country.

But there is one view in which botanical physiology may be of use to agriculture, and that is, in ascertaining correctly the nature, properties, and relative values of plants. To shew the importance of such an investigation, a case may here be specified. A variety of rye-grass, called Italian, has been lately introduced into this country. It is found to be a very free grower in this climate ; and it is highly acceptable to all kinds of live-stock, whether in a green or dried state. Could this grass be rendered certainly perennial, it would be an invaluable acquisition to the pastures of this country. Its character, however, is rather capricious, for in some places it disappears after two years' cultivation, whilst in others it displays undiminished vigour of growth for four or five years, and may perhaps continue so to do for an indefinite period of time. Judging by these various results, it is probable that there is more than one variety of the plant, and distinguishing varieties seem to be known to foreigners. Keeping in view the existence of varieties, if different varieties were affected differently by the same locality, there would be nothing in the phenomenon to excite surprise ; but when the same variety, derived from the same stock, and placed in similar circumstances, exhibits different instances of longevity, there must be characteristics of the plant still unknown to cultivators. In this dilemma, the assistance of the botanical physiologist would be desirable to discover those latent characteristics. It would be desirable to know the conditions that regulate the existence of plants into permanent and temporary varieties,—a property of plants at present involved in mystery. Hitherto, no practical explanation of the subject has been proffered to the farmer; and so long as he shall be permitted to discover the true properties of plants for himself, botanical physiology cannot be regarded by him as of much use to agriculture.

The Italian ryegrass exhibits in its nature an anomaly that no other variety of ryegrass does. The *annual* ryegrass, as it is commonly called, is seldom seen in the ground, even to the extent of a few plants, in any kind of soil, and under any treatment, after the second year; and the *perennial* is as seldom observed to fail in any circumstances, except when it may have been too closely cropped by sheep to the ground too late in autumn, when it generally dies off in the following spring. But the Italian may be annual or perennial in the same circumstances. Farmers cannot account for such an anomaly. High condition of good soil may tend to prolong, whilst the opposite state of poor soil may tend to shorten, its existence. But *why* those circumstances should not produce the same effects on all varieties of ryegrass, it is for science to explain.

Entomology might be made to serve agriculture more than it has yet done. In this department of science, farmers might greatly assist the entomologist, by observing the minute, but varied and interesting, habits of insects. The difficulty of comprehending the true impulses of insects, as well as of identifying species in the different states of transformation, render the observations of farmers less exact than those of entomologists who have successfully studied the technicalities of the science. The field of observation in the insect creation being very wide, and there being comparatively but few explorers in it, a large portion of a man's life would be occupied in merely observing species and their habits, and a much larger in forming general deductions from repeated observation. The result would be, were farmers to study entomology, that a long period must elapse ere the habits of even the most common destructive insects, and the marks of their identity, would become familiarised to them. In consequence of this obstacle to the study of the farmer, the obligation ought to be the greater to those entomologists who daily observe the habits of insects in the fields and woods, and simplify their individual characteristics; and at the same time devise plans to evade their extensive ravages, and recommend simple and effective means for their destruction. The English farmer, living in a climate congenial to the development of insect life, painfully experiences their destructive powers on crops and woods; and, although in England entomologists are ever vigilant and active, yet their efforts easily to overcome the tenacity of insect life, with a regard to the safety of the plant, have hitherto proved unavailing.

Chemistry is somehow imagined to be the science that can confer the greatest benefits on agriculture. This opinion seems confirmed in the minds of most writers and agriculturists, and especially the English, most probably from the circumstance of an eminent chemist having been the first to undertake the explanation of agricultural practice on strictly scientific principles. Sir Humphry Davy has, no doubt, been the cause of bestowing on that science a character, whose influence was imagined to be more capable of benefiting agriculture than its eulogists have since been able to establish. He endeavoured to explain with great acuteness many of the most familiar phenomena of agriculture, when in possession of very limited acquaintance with practical facts; and the result has been, that whilst his own chemical researches have conferred no practical benefit on agriculture—his conclusions being in collision with practice—the field of observation and experiment which he explored and traversed has since been carefully avoided by succeeding chemists, in the conviction, no doubt, that wherein he failed, they were not likely to succeed. The idea seemed never to have struck them, that Sir Humphry had attempted to enforce a connection betwixt chemistry and agriculture which both were incapable of maintaining. Viewing the relation betwixt them merely in a practical point of view, I can see no very obvious connection betwixt tilling the soil, and forcing crops by manure for the support of man and beast,—which is the chief end of agriculture,—and ascertaining the constituent parts of material bodies, organic and inorganic,—which is the principal business of chemistry. A knowledge of the constituent parts of soils, plants, or manures, now forms a necessary branch of general chemical education, but *how* that knowledge *can improve agricultural practice*, has never yet been practically demonstrated. No doubt, chemistry informs us that plants will not vegetate in pure earths, and that those earths constitute the principal basis of all soils; but as pure earths are never found in soils, in their ordinary state, farmers can have no chance of raising crops on them. It may be true, as chemistry intimates, that plants imbibe their food only when in a state of solution; but what avails this fact to agriculture, if fact it be, when manures are only applied in a solid state? It may be quite true, as chemistry declares, that plants cannot supply, from their composition, any substance they have not previously derived from the air, earth, or decomposed organic matter; but of what practical use to agriculture is this declaration, as long as farmers successfully raise every variety of crop from the same manure? Chemistry may be quite correct in its views with regard to all these particulars, but so is practice, and yet both are very far from agreeing; and as long as this constitutes the only sort of information that chemistry affords, it is unimportant to the farmer. He wishes to be shewn *how* to render the soil more fertile, manures more effective, and crops more prolific, by the practical application of chemical principles.

There are many writers, I am convinced, who recommend the study of chemistry to farmers little acquainted with the true objects of chemical research, and not much more with practical agriculture. At all events, they expatiate, only in vague generalities, on the advantages of analyzing soils, manures, &c., but do not attempt to demonstrate *how* any practice of husbandry may *certainly* be improved by the suggestions of chemistry. The truth is, until chemists become thoroughly acquainted with agricultural facts, they cannot see the bearings of chemical principles on agricultural practice, any more than the most uncouth farmer; and until they prove the farmer's practice in any one instance wrong, and are *certain* of its being put right by their suggestions, there is no use of lauding chemistry as a paramount science for agriculture.

In this view of the science, I would rather underrate the ability of chemistry to benefit agriculture, than excite the fallacious hopes of the farmer by extolling it with undue praise. At the same time, were a chemist to recommend suggestions, promising a favourable issue, *that* might tend to excite a well grounded hope in chemical assistance, and I am sure the suggestions would even be fairly tried by farmers who entertain pretty strong suspicions against science. If, for example, on carefully analyzing a plant in common culture, it was found to contain an ingredient which it could not obviously have derived from the manure or the soil, were a suggestion made to mix a quantity of that particular ingredient with the soil or manure, it would at once be cheerfully put to the test of experiment by farmers. If, on the other hand, were the same chemist to suggest making heavy clay land friable by the mechanical admixture of sand, the physical impracticability of the proposal would at once convince the farmer that the chemist had no adequate notion of farm work. And yet propositions as absurd as this have frequently been suggested to farmers by writers who are continually maintaining the ability of chemistry to benefit agriculture. But let me appeal to facts,—to ordinary experience.

I am not aware of a single agricultural practice that has been adopted from the suggestions of chemistry. I am not speaking unadvisedly while making this unqualified statement. In truth, I do not know a single operation of the farm that has not originated in sheer practice. But is it not somewhat unreasonable to expect improvement in agricultural practice, and still more, an entirely improved system of agriculture from the suggestions of chemistry? Some chemical results may appear to bear analogy to certain operations of the farm, such as the preparation of manures; but such analogies, being chiefly accidental, are of themselves insufficient grounds upon which to recommend chemical affinity as the principle which ought to regulate a system of practically mechanical operations. How can the most familiar acquaintance with the chemical constituents of all the substances found on a farm, suggest a different mode of making them into manure, inasmuch as *practice* must first pronounce the treatment to be an improvement, before it can really be an improvement, whatever chemistry may suggest? Besides, chemistry, with all its knowledge of the constituent parts of substances, cannot foretel, more confidently than practice, the results of the combinations with the soil, of the substances analyzed amongst themselves, and the combined effects of these and the soil upon cultivated plants. I am aware that hints may be suggested by science which may prove beneficial to practise; but unless they *accord with the nature of the practice* to which they are proposed to be applied, they are certain of proving unserviceable. Many hints thrown out at random, have frequently been put to the test of experiment; but to experimentize on hints, is quite a different thing in farming, from that sort of farming which is proposed to be entirely based on theoretical suggestions, whether of chemistry or of any other science.

For these reasons, I conceive, chemists would be more usefully employed in following than in attempting to lead practical agriculture. If it were practicable, it would certainly be very desirable for the farmer to be assured that his practice was in accordance with chemical principles; if, for example, it could be explained on chemical principles *why* a certain class of soils is better suited to a certain kind of crop than other classes, and *why* animal manure is better suited than vegetable to a certain kind of crop; when chemistry shall explain *why* certain results are obtained by practice, it will accomplish much, it will elucidate that which was before obscure in principle. Were chemists to confine the first stage of their investigations of agricultural matters to this extent, farmers would be much gratified with the assurance of their practice being in unison with the principles of chemical science; and this would tend more than any other circumstance to inspire them with confidence in the utility of that science. This is the position which chemistry, in my opinion, should occupy in relation to agriculture; for how successful soever it may be in assisting other arts, such as dyeing, soap-making, and ink-making, it assists them both by synthesis and analysis; whereas it can only investigate agricultural subjects by analysis; because every substance employed in agriculture, especially a manure, is used by farmers in the state it is found in the markets, without reference to its chemical constituent parts; and, when used, should an analytical or synthetical process go on amongst those parts, or with the soil, with which they are intimately brought into contact, the process going on in the *soil* would change the chemical composition of the whole, and place them beyond the reach of chemical research. The investigation of the soil after the removal of the crop might then be curious, but nothing more. In this investigation, the farmer, the vegetable physiologist, and the chemist, would all disagree as to the extent of the influence exercised by the favourite substance of each in producing the crop. In settling the question, however, the farmer would have the same advantage over his rivals, in taking possession of the crop as the reward of *his practical* skill, as the lawyer who, in announcing the judgment of the court to two contending parties, gave a shell to each, and kept the oyster to himself.

Of all the sciences, mechanics have proved the most useful to agriculture. If implements may be characterised as the right hand of agriculture, mechanical science, in improving their form and construction, may be said to have given cunning to that right hand; for, mechanical science, testing the strength of materials, both relatively and absolutely, employs no more material in implements than is sufficient to overcome the force of resistance, and it induces to the discovery of that form which overcomes resistance with the least power. Simplicity of construction, beauty of form of the constituent parts, mathematical adjustment, and symmetrical proportion of the whole machine, are now the characteristics of our implements; and it is the fault of the hand that guides them, if field-work is not now dexterously, neatly, and quickly performed. In saying thus much for the science that has improved our implements to the state they now are, when compared with their state some years ago, I am not averring they are quite perfect. They are, however, so far perfect as to be correct in mechanical principle, and light in operation, though not yet simple enough in construction. No doubt many may yet be much simplified in construction; and I consider the machinist who simplifies the action of any useful implement, thereby rendering it less liable to derangement, does as good service to agriculture as the inventor of a new and useful implement.

These are the principles which determine the arrangement adopted in this book. In applying these principles, as the *seasons* supremely rule the destiny of every farming operation, so to them is given full sway over the whole arrangement. This is accomplished by describing every operation *in the season it should be performed,* and this condition necessarily implies the subdivision of the arrangement into *four seasons.* Authors of Farmers' Calendars divide their subject-matter into calendar or fixed months, being apparently inattentive to the influences of the seasons. Such an arrangement cannot fail to create confusion in the minds of young farmers ; as any operation that is directed to be done in any month, may not, in every year, be performed in the same month, on account of the fluctuating nature of the seasons.

In adopting the seasons as the great divisor of the labours of the farm, the months which each season occupies are not specified by name, because the same season does not occupy the same number of months, nor even exactly the same months, in every year. The same work, however, is performed in the same season every year, though not perhaps in the same month or months.

In arranging the seasons themselves, the one which commences the agricultural year, which is *Winter*, has the precedence. The rest follow in the natural succession of Spring, Summer, and Autumn, in which last, all farming operations, having finished their annual circuit, finally terminate. A few remarks, illustrative of its nature, and the work performed in it, are given at the commencement of each season. By comparing these introductory remarks one with the others, the nature of the principal operations throughout the year may be discovered, and by perusing them in succession as they follow, an epitome of the entire farm operations for the year may be obtained.

Throughout the four seasons, from the commencement of winter to the end of autumn, the operations of the farm, both great and small, are described in a continued narrative. This narrative is printed in the largest type used (*small pica*). The reader will soon discover that this narrative does not extend uninterruptedly through the whole pages ; portions of smaller type (*bourgeois*), intervening, and apparently interrupting it. On passing over the small type, it will be perceived that it is really written, and may be perused without interruption. The object of this plan is to permit the necessary descriptions of all the operations, performed in succession throughout the year, to be read in the large type, to the exclusion of every other matter that might distract the attention of the reader from the principal subject. A peristrephic view, so to speak, of the entire operations of the farm is thus obtained. The leading operations forming the principal subjects of the narrative, are distinguished by appropriate titles in CAPITALS placed across the middle of the page. The titles are numbered by the single Roman numeral (thus, 1.) constituting, in the aggregate, a continuous succession of *titles* running, arithmetically numbered, through all the seasons. The leading operations thus easily attract the eye. The minutiæ or minor operations forming the constituent parts of the principal operation to which they belong, each implying some specific change in the principal, is contained in a separate paragraph in the large type, and also numbered with the single Roman numeral, but between parentheses (thus, (1.)), the aggregate of which form a continuous succession of numbered *paragraphs* through all the seasons. A *word* or *words* characterising most explicitly the nature of the minor operation, are put in *italics*, at or near the beginning of each paragraph. Thus not only the principal operations, but all the minor, which they involve, may at once be ascertained. Wood-cut figures of implements, and other objects, requiring no detailed descriptions, and representing at once their form and use, are inserted in the paragraph which alludes to them in the narrative. The reasons for performing both the principal and minor operations, in the manner directed, also form a part of the matter of the narrative.

Implements, on the other hand, that require detailed descriptions to explain, and complicated figures to represent them;—reasons for preferring one mode to another of doing the same kind of work;—and explanations of agricultural practice on scientific principles, together constituting the subsidiary portion of the work, are given in paragraphs in the medium-sized type (*bourgeois*), and this matter in the small type is that which apparently interrupts the principal narrative. Each paragraph is numbered with a single Roman numeral inclosed within parentheses (thus, (1.)) the same as in the principal narrative, and these paragraphs carry on the numbers arithmetically with the paragraphs of the principal narrative. When references are made from the large to the small type, they are made in corresponding numerals. The words most expressively characteristic of the illustration contained in the paragraph, are placed in *italics* at or near the beginning of it.

Marking *all* the paragraphs with numerals, greatly facilitates the finding out of any subject alluded to, saves repetition of descriptions when the same operation is performed in different seasons, and furnishes easy reference to subjects in the index.

Wood-cut figures of the intricate implements, and other objects requiring detailed descriptions, are placed among the descriptions of them in the bourgeois type. Figures of implements, and other objects too intricate to be represented with sufficient distinctness in wood-cuts, or very numerous for one subject, are engraved on steel-plates. The portraits of the animals given are intended to illustrate the *points* required to be attended to in the breeding of the domesticated animals. The portraits are taken from life by eminent artists. The wood-cuts are enumerated as they occur in the order of succession, whether they belong to the large or the small type, and each wood-cut is designated by its distinctive appellation ; both the numeral and appellative being requisite for quick and easy reference.

The matter in the small type appears somewhat like foot-notes in ordinary books; but in this instance, it differs in character from foot-notes, inasmuch as it occurs in unbroken pages at the end of the description of every leading operation. By this plan the principal narrative is not interfered with, and both it and its illustrations may be perused before the succeeding leading operation and its illustrations are taken into consideration. This plan has the advantage of relieving the principal narrative of heavy foot-notes, the perusal of which, when long, not only seriously interrupts the thread of the narrative, but causes the leaves gone over to be turned back again ; both interferences being serious drawbacks to the pleasant perusal of any book.

Foot-notes required either for the principal narrative or illustrations, are distinguished by the usual marks, and printed at the bottom of the page in the smallest type *(Minion)* used in this work.

The paragraphs containing the matter supplied by Mr Slight, are inclosed within brackets (thus, [ ]), and attested by his initials J. S.

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5. OF THE EXISTING METHODS OF LEARNING PRACTICAL HUSBANDRY.

> I have vowed to hold the plough for her sweet love three year.
>
> LOVE'S LABOUR LOST.

I have hinted that there are three states, in one of which the young farmer will be found when beginning to learn his profession. One is, when he himself is born and brought up on a farm, on which, of course, he may acquire a knowledge of farming intuitively as he would his mother tongue. Another is when he goes to school in boyhood, and remains there until ready to embark in the active business of farming; the impressions of his younger years will become much effaced, and he will require to renew his acquaintance with farming as he would of a language that he had forgotten. Young men thus early grounded, generally make the best farmers, because the great secret of knowing practical farming consists in bestowing particular attention on minor operations, which naturally present themselves to the youthful mind before it can perceive the use of general principles. Farmers so brought up seldom fail to increase their capital; and if their education has been superior to their rank in life, frequently succeed in improving their status in society. It is to the skilful conduct and economical management of farmers so situated, that Scotland owes the high station she occupies among the agricultural nations of the world.

The third state in which the learning of farming is requisite, is, when a young man, who has been educated and entirely brought up in a town, or perhaps passed his boyhood in the country, but may have bestowed little attention on farming, wishes to learn it as his profession. In either of these cases, it is absolutely necessary for him to learn it practically on a farm; for total ignorance of his business, and entire dependence on the skill and integrity of his servants, will soon involve him in pecuniary difficulties. To meet the wishes of seekers of agricultural knowledge, there are farmers who receive pupils as boarders, and undertake to teach them practical husbandry.

The chief inducement, as I conceive, which at first prompts young men, who have been nurtured in towns, to adopt farming as a profession, is an undefined desire to lead a country life. The desire often originates in this way. Most boys spend a few weeks in the country during the school vacation in summer, on a visit to relations, friends, or school companions. To them the period of vacation is a season of true enjoyment. Free of the task,—in the possession of unbounded liberty,—untrammelled by the restraints of time,—and partaking of sports new to them and solely appertaining to the country, they receive impressions of a state of happiness which are ever after identified with a country life. They regret the period of return to school,—leave the scene of those enjoyments with reluctance,—and conceive that their happiness would be perpetual, were their hearts wedded to the objects that captivated them. Hence the desire to return to those scenes.

It is conducive to the promotion of agriculture, that young birds of fortune are thus occasionally ensnared by the love of rural life. They bring capital into the profession, or, at all events, it will be forthcoming when the scion of his father's house has made up his mind to become a farmer. Besides, these immigrations into farms are requisite to supply the places of farmers who retire or die out. Various motives operate to bring farms into the market. Sons do not always follow their father's profession, or there may not be a son to succeed, or he may die, or choose another kind of life, or may have experienced ill treatment at home, or been guilty of errors which impel him to quit the paternal roof. For these drains, a supply must flow from other quarters to maintain the equilibrium of agricultural industry. This young race of men, converted into practical farmers, being generally highly born and well educated, assume at once a superior status in, and improve the tone of, rural society. Though they may amass no large fortunes, they live in good style. In the succeeding generation another change takes place. Unless he is well provided with a patrimony, the son seldom succeeds his father in the farm. The father finds he cannot give the farm free of burdens to one son in justice to the rest of the family. Rather than undertake to liquidate *such* a burden by means of a *farm*—that is, from land that is not to be his own—the son wisely relinquishes farming, which, in these circumstances, would be to him a life of pecuniary thraldom.

The young man who wishes to learn farming practically on a farm, should enter upon his task at the end of harvest, as, immediately after that, the preparatory operations commence for raising the next year's crop, and that is the season, therefore, which begins the new-year of farming. He should provide himself with an ample stock of *stout* clothing and shoes, capable of repelling cold and rain, and so made as to answer at once for walking and riding. From the outset, he must make up his mind to encounter all the difficulties I have described under the first head. Formidable as they may seem, I encourage him with the assurance, that it is in his power to overcome them all. The most satisfactory way of overcoming them is to resolve to learn his business in a truly practical manner. Merely being domiciled on a farm is not of itself a sufficient means of overcoming them, for the advantages of residence may be squandered away in idleness, by frequent absence, by spending the hours of work in the house in light reading, or by casual and capricious attendance on field operations. Such habits must be eschewed, before there can be a true desire to become a *practical* farmer. *Every* operation, whether important or trifling, should be *personally* attended to, as there is none but what tends to produce an anticipated result. Attention alone can render them familiar, and without a familiar acquaintance with every operation, the management of a farm need never be undertaken.

Much assistance in promoting this attention should not be *expected* from the farmer. No doubt it is his *duty* to communicate all he knows to his pupils; and, as I believe, most are willing to do so; but as efficient tuition implies constant attendance on work, the farmer himself cannot constantly attend to every operation, or even explain any, unless his attention is directed to it; and much less will he deliver extempore lectures at appointed times. Reservedness in him, does not necessarily imply *unwillingness* to communicate his skill; because, being himself familiar with every operation that can arrest the attention of his pupils, any explanation of minutiæ at any other time than when the work is in the act of being performed, and when only it could be *understood* by the pupils, would only serve to render the subject more perplexing. In these circumstances the best plan for the pupil to follow, is to *attend constantly*, and *personally observe* every change that takes place in every piece of work. Should the farmer happen to be present, and be appealed to, he will, as a matter of course, immediately clear up every difficulty in the most satisfactory way; but should he be absent, being otherwise engaged, then the steward or grieve, or any of the ploughmen, or shepherd, as the nature of the work may be, will, on inquiry, afford as much information on the spot as will serve to enlighten his mind until he associates with the farmer at the fireside.

To be enabled to discover that particular point in every operation, which, when explained, renders the whole intelligible, the pupil should put his hand to every kind of work, be it easy or difficult, irksome or pleasant. Experiences acquired by himself, however slightly affecting his mind,—desirous of becoming acquainted with every professional incident,—will solve difficulties much more *satisfactorily* than the most elaborate explanations given by others. The larger the stock of these personal experiences he can accumulate, the sooner will the pupil understand the purport of every thing that occurs in his sight. Daily opportunities occur on a farm for joining in work, and acquiring those experiences. For example, when the ploughs are employed, the pupil should walk from the one to the other, and observe which ploughman or pair of horses perform the work with the greatest apparent difficulty or ease. He should also mark the different styles of work executed by each plough. A considerate comparison of these particulars, will enable him to ascertain the best and worst specimens of work. He should then endeavour to discover the cause why different styles of work are produced by apparently very similar means, in order to enable himself to rectify the worst and practise the best. The surest way of detecting error and discovering the best method, is to take hold of each plough successively, and he will find in the endeavour to maintain each in a steady position, and perform the work evenly, that all require *considerable* labour—every muscle being awakened into energetic action, and the brow most probably moistened. As these symptoms of fatigue subside with repetitions of the exercise, he will eventually find one of the ploughs more easily guided than any of the rest. The reasons for this difference he must himself endeavour to find out by comparison, for its holder cannot inform him, because he professes to have, indeed can have, no knowledge of any other plough but his own. In prosecuting this system of trials with the ploughs, he will find himself becoming a ploughman, as the mysteries of the art divulge themselves to his apprehension; but the reason why the plough of one of the men moves more easily, does better work, and oppresses the horses less than any of the rest, is not so obvious; for the land is in the same state to them all, there cannot be much difference in the strength of the pairs of horses, as each pair are generally pretty well matched, and in all probability the construction of the ploughs is the same, if they have been made by the same ploughwright, yet one ploughman evidently exhibits a decided superiority in his work over the rest. The inevitable conclusion is, that ploughman understands his business better than the others. He shews this by trimming the irons of his plough to the state of the land, and the nature of the work he is about to perform, and by training his horses more in accordance with their natural temperament, whereby they are guided more tractably. Having the shrewdness to acquire these essential accomplishments to a superior degree, the execution of superior work is an easier task to him than inferior work to the other ploughmen. This case which I have selected for an example, is not altogether a supposititious one; for however dexterous all the ploughmen on a farm may be, one will always be found to shew a superiority over the rest.

Having advanced thus far in the knowledge and practice and capability of judging of work, the pupil begins to feel the importance of his acquisition; and this success will fan the flame of his enthusiasm, and prompt him to greater acquirements. But even in regard to the plough, the pupil has much to learn. Though he has picked out the best ploughman, and knows why he is so, he is himself still ignorant of how practically to trim a plough, and to drive the horses with discretion. The ploughman will be able to afford him ocular proof *how* he places *(tempers)* all the irons of the plough in relation to the state of the land, and *why* he yokes and drives the horses as he does in preference to any other plan. Illiterate and unmechanical as he is, and his language full of *technicalities*, his explanations will nevertheless give the pupil a clearer insight into the *minutiæ* of ploughing, than he could acquire by himself as a spectator in an indefinite length of time.

I have selected the plough, as being the most useful implement to illustrate the method which the pupil should follow, in all cases, to learn a *practical* knowledge of every operation in farming. In like manner, he may become acquainted with the particular mode of managing all the larger implements, which require the combined agency of man and horse to put into action; as well as become accustomed to wield the simpler implements used by the hand, easily and ambidextrously, a great part of farm-work being executed with simple but very efficient tools. Frequent *personal* attendance at the farm-stead, during the winter months, to view and conduct the thrashing-machine, while thrashing corn, and afterwards to superintend the winnowing-machine, in cleaning it for the market, will be amply repaid by the acquisition of essential knowledge regarding the nature and value of the cereal and leguminous grains. There is, moreover, no better method of acquiring an extensive knowledge of *all* the minor operations of the farm, than for the pupil personally to superintend the labours of the field-workers. Their labours are essential, methodical, almost always in requisition, and mostly consisting of minutiæ; and their general utility is shewn, not only in their intrinsic worth, but in relation to the labours of the teams.

The general introduction of sowing-machines, particularly those which sow broadcast, has nearly superseded the beautiful art of sowing corn by hand. Still a great deal of corn is sown by the hand, especially on small farms, on which expensive machines have not yet found their way. In the art of hand-sowing, the pupil should endeavour to excel, for, being difficult to perform it in an easy and neat manner, the superior execution of it is regarded as an accomplishment. It is, besides, a manly and healthful exercise, conducive to the establishment of a robust frame and sound constitution.

The feeding of cattle in the farm-stead, or of sheep in the fields on turnips, does not admit of much participation of labour with the cattle-man or shepherd; but nevertheless, either practice will form an interesting subject of study to the pupil, and without strict attention to both, he will never acquire a knowledge of fattening live-stock, and of computing their value.

By steadily pursuing the course of observation which I have thus chalked out, and particularly in the first year of his apprenticeship, the pupil, in a short time, will acquire a *considerable* knowledge of the minutiæ of labour; and it is only in this way that the groundwork for a familiar acquaintance with them can be laid. A truly familiar acquaintance with them requires years of experience. Indeed, observant farmers are learning some new, or modifications of some old, practice every day, and such new-like occurrences serve to keep alive in them a regard for the most trivial incident that happens on a farm.

In urging upon the pupil the *necessity* of putting to his hand to every kind of labour, I do not mean to say he should become a first-rate workman. To become so would require a much longer time than he could spare in a period of pupilage. His personal acquaintance with every implement and operation should, however, enable him by that time to decide quickly, whether work is well or ill done, and whether it has been executed in a reasonable time. No doubt this extent of knowledge may be acquired *in time*, without the actual labour of the hands; but, as it is the interest of the pupil to learn his profession not only in the shortest possible time, but in the best manner, and as these can be acquired sooner through the joint co-operation of the head and hands, than by either singly, it would seem imperative on him to begin to acquire his profession by labour.

Other considerations regarding the acquisition of practical knowledge deserve the attention of the pupil. It is most conducive to his interest to learn his profession in youth, and before the meridian of life has set in when labour of every kind becomes irksome. It is also much better to have a *thorough* knowledge of farming, *before* engaging in it on his own account, than to acquire it in the course of a lease, during which heavy losses may be incurred by the commission of comparatively trivial errors, especially at the early period of its tenure, when farms in all cases are most difficult to conduct. It is an undeniable fact, that the work of a farm never proceeds *so* smoothly and satisfactorily to all parties engaged in its culture, as when the farmer is thoroughly master of his business. His orders are then implicitly obeyed, not because they are pronounced more authoritatively, but because a skilful master's plans and directions inspire that degree of confidence in the labourers as to believe them to be the best that could be devised in the circumstances. Shame is often acutely felt by servants, on being detected in error, whether of the head or heart, by so competent and discriminating a judge as a skilful master; because rebuke from such a one implies ignorance or negligence in those against whom it is directed. The fear of having ignorance and idleness imputed to them, by a farmer who has become acquainted with the capabilities of work-people by dint of his own experience, and can estimate their services as they really deserve, urges labourers to do a fair day's work in a workmanlike style.

Let the converse of all these circumstances be imagined; let the losses to which the ignorant farmer is a daily prey, by many ways—by hypocrisy, by negligence, by idleness, and by dishonesty of servants—be calculated, and it must be admitted that it is infinitely safer for the farmer to trust to his own skill for the fulfilment of his engagements, than entirely to depend on that of his servants, which he will be obliged to do, if they know his business better than he himself does. No doubt a trust-worthy steward may be found to manage well enough for him, and such an assistant is at all times valuable: but, in such a position, the steward himself is placed in a state of temptation, in which he should never be put; and, besides, the inferior servants never regard him as a master and his orders are never so punctually obeyed, where the master himself is resident. I would, therefore, advise every young farmer to acquire a *competent* knowledge of his profession, before embarking in the complicated undertaking of conducting a farm. I only say a competent knowledge; for the gift to excel is not imparted to all who select farming as their profession; " it is not in man who walketh to direct his *steps*" aright, much less to attune his *mind* to the highest attainments.

Before the pupil fixes on any particular farm for his temporary abode, he should duly consider the objects he wishes to attain. I presume his chief aim is to attain such an intimate knowledge of farming, as to enable him to employ his capital safely, in the prosecution of the highest department of his profession. This will probably be best attained by learning that system which presents the greatest safeguards against unforeseen contingencies. Now, there is little doubt that the kind of farming which cultivates a variety of produce, is more likely to be safe, during a lease, in regard both to highness of price and quantity of produce, than that which only raises one kind of produce, whether wholly of animals, or wholly of grain. For, although one kind of produce, when it happens to be prolific or high priced, may, in one year, return a greater profit than a variety of produce in the same year; yet the probabilities are much against the frequent recurrence of such a circumstance. The probability rather is, that one of the varieties of produce will succeed, in price or produce, every year, and therefore in every year there will be a certain degree of success in that mode of farming which raises a variety of produce. Take, as an example, the experience of late years. All kinds of live-stock have been reared with profit for some years past; but the case is different in regard to grain. Growers of grain have suffered greatly in their capital in that time. And yet, to derive the fullest advantages from even the rearing of stock, it is necessary to cultivate a certain extent of land upon which to raise straw and green crop for them in winter. Hence that system is the best for the young farmer to learn, which cultivates a relative proportion of stock and crop, and not either singly. This has been characterised as the *mixed* system of husbandry. It avoids, on the one hand, the monotony and inactivity attendant on the raising of grain, and subdues, on the other, the roving disposition engendered in the tending of live-stock in a pastoral district; so it blends both occupations into a happy union of cheerfulness and quiet.

Most farmers in the lowlands of Scotland practise the mixed husbandry, but it is reduced to a perfect system nowhere so fully as in the Border counties of England and Scotland. There many farmers accept pupils, and thither many of the latter go to prepare themselves to become farmers. The usual fee for pupils, in that part of the country, is one hundred pounds per annum for bed and board, with the use of a horse to occasional markets and shows. If the pupil desire to have a horse of his own, about thirty pounds a-year more are demanded. On these moderate terms, pupils are generally very comfortably situated.

I am very doubtful of it being good policy to allow the pupil a horse of his own at first. Constant attention to field-labour is not unattended with irksomeness, and, on the other hand, exercise on horseback is a tempting recreation to young minds. Besides, the desire to possess a horse of one's own, is so very natural in a young person living in the country, that, were the pupil's inclinations alone consulted, the horse would soon be in his possession. So long as the choice is given to the indifferent pupil, he will certainly prefer pleasure to duty. The risk is, that the indulgence will be confirmed into a habit that will constantly lead him astray from attending to his business. Were his equestrian excursions confined to following the hounds upon all occasions, forming acquaintances at a distance from home, and loitering about towns on market-days, the roving pupil might see the state of the country, and acquire a knowledge of the world; but the evil of this kind of life is its being introductory to one of dissipation and extravagance. This consideration should have due weight with parents and guardians, in supplying their charge with the luxury of a horse, when placing him under the roof of a farmer. It is enough for a young man to feel the removal of parental restraint, without also having the dangerous incentive of an idle life placed at his disposal. They should consider that upon young men arrived at the years when they become farming pupils, it is not in the power, and is certainly not the inclination, of farmers to impose ungracious restraints. It is the duty of their parents and guardians to impose these; and the most effectual way that I know of, in the circumstances, to avoid temptations, is the denial of a riding-horse. Attention to business in the first year, will most probably induce a liking for it in the second, and after that, the indulgence of a horse may be granted to the pupil with impunity, as the reward of diligence. Until then, the horse occasionally supplied by the farmer, to attend particular markets, or pay friendly visits to neighbours, should suffice; and, as that is the farmer's own property, it will be more in his power to curb in his pupils any propensity to wander abroad too frequently, and thereby preserve his own character as a tutor. Such precautions are, of course, only necessary against pupils who shew lukewarmness towards farming. The prudent and diligent pupil who desires to learn his profession, will daily discover new sources of enjoyment at home, far more exhilarating, both to his body and mind, than in jogging along the dirty or dusty highway, until the jaded brute he bestrides is ready to sink under his burden.

Three years of apprenticeship are, in my opinion, requisite to give a pupil an adequate knowledge of farming,—such a knowledge, I mean, as would impress him with the confidence of being himself able to manage a farm; and no young man should undertake such a management until he feels this confidence in himself. Three years may be considered by many as too long a time to spend in learning *farming;* but after all, it is much less time than that given to many other professions, whose period of apprenticeship extends to five and even seven years; and however highly esteemed those professions may be, none possess a deeper interest, in a national point of view, than that of agriculture. There is a condition attendant on the art of farming, which is common to it and gardening, but inapplicable to most other arts,—that a year must elapse before the same work can again be performed. Whatever may be the ability of the learner to acquire farming, *time* must thus necessarily elapse before he can have the opportunity of again witnessing a bygone operation. There is no doubt of his natural capacity to acquire, in two years, the art to manage a farm, but the operations necessarily occupying a year in their performance, prevents that acquisition in less time than three. This circumstance of itself will cause him to spend a year in merely observing passing events. This is in his first year. As the operations of farming are all anticipatory, the second year may be fully employed in studying the progress of work in preparation of anticipated results. In the third year, when his mind has been stored with all the modes of doing work, and the purposes for which they are performed, the pupil may attempt to put his knowledge into practice, and his first efforts at management cannot be attempted with so much ease of mind to himself, as, on the farm of his tutor, under his correcting guidance.

This is the *usual* progress of tuition during the apprenticeship of the pupil; but could he be brought to anticipate results whilst watching the progress of passing events, one year might thus be cut off his apprenticeship. Could a *book* enable him to acquire the experience of the second year in the course of the first, a year of probationary trial would be saved him, as he would then acquire in two what requires three years to accomplish. *This* book will accomplish no small achievement,—will confer no small benefit on the agricultural pupil,—if it accomplish this.

6. OF THE ESTABLISHMENT OF SCIENTIFIC INSTITUTIONS OF PRACTICAL AGRICULTURE.

> "Here let us breathe, and happily institute
> A course of learning and ingenious studies."
>
> TAMING OF THE SHREW.

Although I know of no existing plan so suited to the learning of practical farming, as a protracted residence on a farm, yet I feel assured a more efficient one might easily be proposed for the purpose. An evident and serious objection against the present plan is the want of that solicitous superintendence over the progress of the pupils, on the part of the farmer, which is implied in his receiving them under his *charge*. The pupils are left too much to their own discretion to learn farming effectually. They are not sufficiently warned of the obstacles they have to encounter at the outset of their career. Their minds are not sufficiently guarded against receiving a wrong bias in the methods of performing the operations. The advantages of performing them in one way rather than another, are not sufficiently indicated. The effects which a change of weather has in altering the arrangements of work fixed upon, and of substituting another more suited to the change, is not sufficiently explained. Instead of receiving explanatory information on these and many more particulars, the pupils are mostly left to find them out by their own diligence. If they express a desire to become acquainted with these things, no doubt it will be cheerfully gratified by the farmer; but how can the uninitiated pupil know the precise subject with which to express his desire to become acquainted?

In such a system of tuition, it is obvious that the diligent pupil may be daily perplexed by doubtful occurrences, and the indifferent pupil permit unexplained occurrences to pass before him, without notice. Reiterated occurrences will, in time, force themselves upon the attention of every class of pupils; but unless their attention is purposely drawn to, and explications proffered of, the more hidden difficulties in the art of farming, they will spend much time ere they be capable of discovering important occult matters by their own discernment.

It is in this respect that farmers, who profess to be tutors, shew, as I conceive, remissness in their duty to their pupils; for all of them can impart the information alluded to, and give, besides, a common-sense explanation of every occurrence that usually happens on a farm, otherwise they should decline pupils.

It is obvious that pupils should not to be placed in this disadvantageous position. They ought to be *taught* their profession; because the art of husbandry should be acquired, like every other art, by teaching, and not by intuition. On the other hand, pupils in this, as in every other art, ought to endeavour to acquire the largest portion of the knowledge of external things by their own observation; and they should be made aware by the farmer, that he can at most only *assist* them in their studies; so that, without much study on their parts, all the attention bestowed on their tuition by the most painstaking farmer will prove of little avail. Practical experience forms the essential portion of knowledge which farmers have to impart, and it is best imparted on the farm; but they have not always the leisure, by reason of their other avocations, to communicate even this on the spot in its due time. More than mere practical knowledge, however, is requisite to satisfy the mind of the diligent pupil. He wishes to be satisfied that he is learning the *best* method of conducting a farm: He wishes to be informed of the *reasons* why one mode of management is preferable to every other: He wishes to become *familiar* with the explanations of all the phenomena that are observable on a farm.

To afford all the requisite information to the pupil in the highest perfection, and to assist the farmer in affording it to him in the easiest manner, I propose the following plan of tuition for adoption, where circumstances will permit it to be established. The more minutely its details are explained, the better will it be understood by those who may wish to form such establishments.

Let a farmer of good natural abilities, of firm character, fair education, and pleasant manners, leasing a farm of not less than five hundred acres, and pursuing the mixed system of husbandry, occupy a house of such a size as would afford accommodation to from ten to twenty pupils. The farm should contain different varieties and conditions of soil,—be well fenced,—well watered,—and not at an inconvenient distance from a town.

With regard to the internal arrangements of the house, double-bedded rooms would form suitable enough sleeping apartments. Besides a dining-room and drawing-room, for daily use, there should be a large room, fitted up with a library, containing books affording *sound* information on all agricultural subjects, in various languages; forming at one time a lecture-room for the delivery of lectures on the elementary principles of those sciences which have a more immediate reference to agriculture, and at another a reading or writing room or parlour for conversations on farming subjects. There should be fixed, at suitable places, a barometer, a sympiesometer, thermometers, one of which should mark the lowest degree of temperature in the night, a rain-gauge, an anemometer, and a weathercock. No very useful information, in my opinion, can be derived by the *farmer*, from a bare *register* of the heights and depths of the barometer and thermometer. A more useful register for him would be that of the directions of the wind, accompanied with remarks on the state of the weather, the heat of the air as indicated by the feelings, and the character of the clouds as expressed by the most approved nomenclature. The dates of the commencement and termination of every leading operation on the farm should be noted down, and appropriate remarks on the state of the weather during its performance recorded. A small chemical laboratory would be useful in affording the means of analyzing substances whose component parts were not well known. Microscopes would be useful in observing the structure of plants and insects, for the better understanding of their respective functions.

The slaughter-house required for the preparation of the meat used by the family should be fitted up to afford facilities for dissecting those animals which have been affected by peculiar disease. Skeletons and preparations for illustrating comparative anatomy could thus be formed with little trouble. A roomy dairy should be fitted up for performing experiments on the productive properties of milk in all its various states. A portion of the farm-offices should be fitted up with apparatus for making experiments on the nutritive properties of different kinds and quantities of food, and the fattening properties of different kinds of animals. A steelyard, for easily ascertaining the live-weight of animals, is a requisite instrument. The bakery, which supplies the household bread, would be a proper place for trying the relative panary properties of different kinds of flour and meal. Besides these, apparatus for conducting experiments on other subjects as they were suggested, could be obtained when required.

Another person beside the farmer will be required to put all this apparatus into use. He should be a man of science, engaged for the express purpose of shewing the relation betwixt science and agriculture. There would be no difficulty of obtaining a man of science, quite competent to explain natural phenomena on scientific principles. For that purpose, he would require to have a familiar acquaintance with the following sciences:—with meteorology and electricity, in order to explain atmospherical phenomena, upon the mutations of which all the operations of farming are so dependent:—with hydrostatics and hydraulics, to explain the action of streams and of dammed-up water on embankments, to suggest plans for the recovery of land from rivers and the sea, and to indicate the states of the weather which increase or diminish the statical power of the sap in vegetables:—with botany and vegetable physiology, to shew the relations between the natural plants and the soils on which they grow, with a view to establish a closer affinity between the artificial state of the soil and the perfect growth of cultivated plants; to exhibit the structure of the different orders of cultivated plants; and to explain the nature and uses of the healthy, and the injurious effects of the diseased secretions of plants:—with geology, to explain the nature, and describe the structure, of the superficial crust of the earth, in reference to draining the soil; to shew the effects of subsoils on the growth of trees; to explain the effects of damp subsoils, on trees, and of the variations of the surface of the ground, on climate:—with mechanics, to explain the principles which regulate the action of all machines; and which acquirement previously implies a pretty familiar acquaintance with the mathematics:—with chemistry, to explain the nature of the composition of, and changes in, mineral, vegetable, and animal substances:—with anatomy and animal physiology, to explain the structure and functions of the animal economy, with a view to the prevention of disease, incidental to the usual treatment of animals, and to particular localities. All young men, educated for what are usually termed the learned professions,—theology, law, and medicine,—are made acquainted with these sciences, and a young man from either faculty would be competent to take charge of such an establishment. Of the three I would give preference to the *medical* man, as possessing professionally a more intimate knowledge of chemistry, and animal and vegetable physiology, than the others. But the most learned graduate of either profession, will display his scientific acquirements to little advantage in teaching pupils in agriculture, unless he has the judgment to select those parts of the various sciences, whose principles can most satisfactorily explain the operations of agriculture. Ere he can do this successfully, he would, I apprehend, require to know agriculture practically, by a previous residence of at least two years on a farm. Without such a preparation, he would never become a *useful* teacher of agricultural pupils.

On the supposition that he is so qualified, his duty is to take the direct charge of the pupils. His chief business should be to give demonstrations and explanations of all the phenomena occurring during operations in the farm field. The more popular demonstrations on botany, animal and vegetable physiology, and geology, as also on meteorology, optics, and astronomy, whenever phenomena occur which would call forth the application of the principles of any of those sciences, would be best conducted in the fields. In the library, short lectures on the elementary principles of science could be regularly delivered,—conversations on scientific and practical subjects conducted,—and portions of the most approved authors on agriculture, new and old, read. These latter subjects could be most closely prosecuted when bad weather interrupted field labour. In the laboratory, slaughter-house, farm-stead, and dairy, he could command the attendance of the pupils, when any subject in those departments were to be explained.

The duty of the farmer himself, the governor or head of the establishment, is to enforce proper discipline among the pupils, both within and without doors. He should teach them practically how to perform every species of work, explain the nature and object of every operation performing, and foretel the purport of every operation about to be performed. For these important purposes he should remain at home as much as is practicable with his avocations abroad.

The duties of the pupils are easily defined. They should be ready at all times to hear instruction, whether in science or practice, within or without doors. Those pupils who wish to study practice more than science, should not be constrained to act against their inclinations, as science possesses little allurement to some minds; and it should be borne in mind by the tutors, that practical farming is what the pupils have chiefly come to learn, and that practice may prove successful in after life without the assistance of science, whereas science can never be applied without practice.

The duty common to all, is the mutual conducting of experiments, both in the fields and garden; for which purpose, both should be of ample dimensions. All new varieties of plants might be first tried in the garden, until their quantity warranted the more profuse and less exact, though more satisfactory, culture of the field. On ridges in the fallow field, with different kinds and quantities of manure, and different modes of working the soil and sowing the seeds, experiments should be continually making with new and old kinds of grains, roots, tubers, bulbs, and herbaceous plants. In course of time, the sorts best suited to the locality will shew themselves, and should be retained, and the worthless abandoned. In like manner, experiments should be made in the crossing of animals, whether with the view of maintaining the purity of blood in one, the improvement of the blood of another, or the institution of an entirely new blood. In either class of experiments, many new and interesting facts, regarding the constitutional differences of animals, could not fail to be elicited.

Any farmer establishing such an institution, which could only be done at considerable expense, in fitting up a house in an adequate manner, and securing the services of a man of science, would deserve to be well remunerated. I before mentioned that one hundred pounds a-year as board were cheerfully given by pupils to farmers under ordinary circumstances. In such an institution, less than one hundred and fifty pounds a-year would not suffice to remunerate the farmer. Supposing that ten pupils at that fee each, were accommodated on one farm, the board would amount to fifteen hundred pounds a-year. In regard to the expense of maintaining such an establishment, with the exception of foreign produce and domestic luxuries, all the ordinary means of good living exist on a farm. The procuring of these necessaries and luxuries, and maintaining a retinue of grooms and domestic servants, together with the salary of an accomplished tutor, which should be not less than three hundred pounds a-year, besides board, would probably incur an annual disbursement of a thousand pounds a-year. The farmer would thus receive five hundred pounds a-year for risk of the want of the full complement of pupils, and for interest on the outlay of capital. Such a profit may be considered a fair, but not an extravagant remuneration for the comfortable style of living, and superior kind of tuition afforded in such an establishment.

Were the particulars pitched at a lower scale, a profit might be derived from ten pupils, of not less a sum than that derived from the usual board of one hundred pounds a-year. Were two hundred a-year exacted, pupils of the highest class of society might be expected. Were different institutions at different rates of board established, all the classes of society would be accommodated.

Would farmers who have accommodation for conducting such an institution, but duly consider the probable certainty of obtaining a considerable increase to their income, besides the higher distinction of conducting so useful an institution, I have no doubt many would make the attempt. There are insuperable obstacles to some farmers making the attempt; but there are many who possess the requisite qualifications of accommodation in house and farm locality, personal abilities, influence, and capital, for instituting such an establishment. But even where all these qualifications do not exist, most of the obstacles might be overcome. In the case of the house, it could be enlarged at the farmer's own expense, for the landlord cannot be expected to erect a farm-house beyond the wants of an ordinary family; nor, perhaps, would every small landed proprietor permit the unusual enlargement of a farm-house, in case it should be rendered unsuitable to the succeeding tenant. To avoid this latter difficulty, the farmer who could afford accommodation to the fewest number, could receive the highest class of pupils, were his own education and manners competent for the highest society, while those who had more accommodation could take a more numerous and less elevated rank of pupils. In either way the profit might be equally compensatory.

In regard to other considerations, a tutor entirely competent could not at once be found. It may safely be averred, that a really scientific man, thoroughly acquainted with the practice of agriculture, is not to be found in this country. But were a demand for the services of scientific men to arise, from the increase and steady prosperity of such establishments, no doubt, men of science would qualify themselves for the express purpose. As to pupils, the personal interest of the farmer might not avail him much at first, in influencing parents in his favour, but if he possess the reputation of being a good farmer, he would soon acquire fame for his institution. I have no doubt of an eminent farmer entirely succeeding to his wishes, who occupies a commodious house, on a large farm, in an agricultural district of high repute, and possessing sufficient capital, were he to make the experiment, by engaging a competent scientific tutor, and teaching the practical department himself. Such a combination of alluring circumstances could not fail of attracting pupils from all parts of the country, who were really desirous of learning agriculture in a superior manner.

There might still be another, though less attractive and efficacious, mode of accomplishing a similar end. Let a scientific tutor, after having acquired a competent knowledge of practical agriculture, procure a commodious and comfortable house, in any village in the vicinity of some large farms, in a fine agricultural district. Let him receive pupils into his house, on his own account, in such numbers, and at such fees, as he conceives would remunerate him for his trouble and risk. Every thing relating to science within doors, could be conducted as well in such a house as in any farm-house; and as to a field for practice, let the tutor give a douceur to each of the large farmers in his neighbourhood, for liberty for himself and pupils to come at will, and inspect all the operations of the farms. In this way a very considerable knowledge of farming might be imparted. Having every article of consumption to purchase at market-price, such an establishment would cost more to maintain than that on a farm; but, on the other hand, the salary of the tutor would in this case be saved, and there would be no farmer and his family to support. To assist in defraying the extra expenses of such an establishment, let the tutor permit, for a moderate fee, the sons of those farmers whose farms he has liberty to inspect, and of those who live at a distance, to attend his lectures and readings in the house, and his prelections in the fields. A pretty extensive knowledge of, and liking for, the science of agriculture might thus be diffused throughout the country, amongst a class of young farmers who might never have another opportunity of acquiring it, because they would never become permanent inmates in any such establishment.

I have known a mode of learning farming adopted by young farmers of limited incomes, from remote and semicultivated parts of the country, of lodging themselves in villages in cultivated districts adjacent to large farms, occupied by eminent farmers, and procuring leave from them to give their daily personal labour and superintendence in exchange for the privilege of seeing and participating in all the operations of the farm.

There are still other modes than those described above of learning farming, which deserve attention, and require remark. Among these the only one in this country, apart from the general practice of boarding with practical farmers, is the Class of Agriculture in the University of Edinburgh. This Chair was endowed in 1790 by Sir William Pulteney, with a small salary, and placed under the joint patronage of the Judges of the Court of Session, the Senatus Academicus of the University of Edinburgh, and the Town-Council of the City of Edinburgh. The first professor elected by the patrons to this chair in 1791, was the late Dr Coventry, whose name, in connection with the agriculture of the country, stood prominent at one time. He occupied the chair until his death in 1831. His prelections, at the earlier period of his career as a professor, were successful, when his class numbered upwards of seventy students. When I attended it, the number of students was upwards of forty. Dr Coventry was a pleasing lecturer, abounding in anecdote, keeping his hearers always in good humour, courting interrogation, and personally shewing great kindness to every student. At the latter period of his incumbency, the class dwindled away, and for some years before his death, he delivered a course of lectures only every two years. He delivered, I understand, thirty-four courses in forty years.

The present Professor Low succeeded Dr Coventry. Since his installation into the chair, he has rekindled the dying embers of the agricultural class, by delivering an annual course of lectures suited to the improved state of British agriculture, and by forming a museum of models of agricultural implements, and portraits of live-stock, illustrative of his lectures, of the most extensive and valuable description. In Dr Coventry's time, there was no museum deserving the name, and seeing this, Professor Low had no doubt been impressed with the important truth, that without models of the most approved implements, and portraits of the domesticated animals, serving to illustrate the principal operations and breeds of animals to be seen on the best cultivated farms, and pastoral districts, a mere course of lectures would prove nugatory. This museum is attached to the University, and to shew the zeal and industry by which the present Professor has been actuated in its formation, the objects in it must be worth more than L.2000. The funds which obtained those objects were derived from the revenues under the management of the Board of Trustees for the encouragement of Arts and Manufactures in Scotland. This Board was instituted by the 15th Article of the Treaty of Union between Scotland and England. Besides forming the museum, Professor Low has, during his yet short incumbency in the chair, already contributed much important matter to the agricultural literature of the country, by the publication of his Elements of Practical Agriculture, which contain almost the entire substance of his lectures, and the series of coloured portraits of animals taken from the pictures in the museum, now coming out periodically in numbers.

There has lately been appointed a lecturer on agriculture in Marischal College, Aberdeen, at a salary of L.40 a-year. Being but an experiment, the appointment, I believe, has only been made for three years.

There is no public institution in England for teaching agriculture. Some stir is making in the establishment of an Agricultural College in Kent, the prospectus of which I have seen; and, some time ago, I saw a statement which said that provision exists for the endowment of a Chair of Agriculture in one of the Colleges of Oxford.

An agricultural seminary has existed at Templemoyle in the county of Londonderry, Ireland, for some years. It originated with the members of the North-west of Ireland Farming Society, and the first intention was to form it on such a scale as to teach children of the higher orders every science and accomplishment, whilst those of the lower orders, the sons of farmers and tradesmen, were to be taught agriculture. But the latter arrangement only has been found to be practicable. In a statement circulated by a member of the committee, I find that "the formation of this establishment has caused its founders an expenditure of above L.4000, of which about L.3000 were raised at its commencement by shares of L.25 each, taken by the noblemen, gentlemen, and members of the North-west Society. The Grocers' Company of London, on whose estate it is situated, have been most liberal in their assistance, and have earned a just reward in the improvement of their property, by the valuable example the farm of Templemoyle presents to their tenantry.

"In sending a pupil to Templemoyle, it is necessary to have a nomination from one of the shareholders, or from a subscriber of L.2 annually. The annual payment for pupils is L.10 a-year, and for this trifling sum they are found in board, lodging, and washing, and are educated so as to fit them for land-stewards, directing agents, practical farmers, schoolmasters, and clerks. From fifteen to seventeen is the age best suited to entrance at Templemoyle, as three years are quite sufficient to qualify a student possessed of ordinary talents, and a knowledge of the rudiments of reading and writing, to occupy any of the above situations.

"Upwards of two hundred young men, natives of sixteen different counties in Ireland, have passed or remain in the school. Of these, between forty and fifty have been placed in different situations, such as land-stewards, agents, schoolmasters, and clerks, or employed on the Ordnance Survey. Nearly one hundred are now conducting their own or their father's farms, in a manner very superior to that of the olden time.

"The school and farm of Templemoyle are situated about six miles from Londonderry; about a mile distant from the mailcoach-road leading from Londonderry to Newtonlimavady. The house, placed on an eminence, commands an extensive and beautiful view over a rich and highly cultivated country, terminated by Lough Foyle. The base of the hill is occupied by a kitchen and ornamental garden, cultivated by the youths of the establishment, under an experienced gardener. The house and farm-offices behind contain spacious, lofty, and well ventilated school-rooms; refectory; dormitories; apartments for the masters, matron, servants, &c. Each pupil occupies a separate bed; the house can accommodate seventy-six, and the number of pupils is sixty. They receive an excellent education in reading, writing, arithmetic, book-keeping, mathematics, land-surveying, and geography. This department is managed by an excellent head-master, and assistant-master, both resident in the house. The pupils are so classed that one-half are receiving their education in the house, while the remainder are engaged in the cultivation of a farm of 165 Scotch acres, in the management of which they are directed by the head-farmer, an experienced and clever man, a native of Scotland, who has a skilful ploughman under him. The pupils who are employed one part of the day on the farm, are replaced by those in the school, so that the education always advances in and out of doors *pari passu*." *

In enumerating the means of obtaining agricultural knowledge in this country, I cannot omit mentioning those co-assistant institutions, the Veterinary Colleges. Their great object is to form a school of veterinary science, in which the anatomical structure of quadrupeds of all kinds, horses, cattle, sheep, dogs, &c., the diseases to which they are subject, and the remedies proper to be applied for their removal, might be investigated and regularly taught; in order that, by this means, enlightened practitioners of liberal education, whose sole study has been devoted to the veterinary art in all its branches, may be gradually dispersed over all the kingdom. The Veterinary College of London was instituted in 1791, according to the plan of Mr Sain Bel, who was appointed the first professor. Parliamentary grants have been afforded at times to aid this institution, when its finances rendered such a supply essential. It is supported by subscription. Every subscriber of the sum of L.21 is a member of the society for life. Subscribers of two guineas annually are members for one year, and are equally entitled to the benefits of the institution. A subscriber has the privilege of having his horses admitted into the infirmary, to be treated, under all circumstances of disease, at 3s. 6d. per night, including keep, medicines, or operations of whatever nature that may be necessary; likewise of bringing his horses to the college for the advice of the professor *gratis*, in cases where he may prefer the treatment of them at home.* Until last year, care was chiefly bestowed in this institution on the horse, when the Royal Agricultural Society of England, deeming it as important for the promotion of agriculture, to attend to the diseases of the other animals reared on farms as well as the horse, voted L.300 a-year out of their funds for that purpose.

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* Irish Farmer's Magazine, No. 51.

The Veterinary College of Edinburgh had its origin in the personal exertions of its present professor, Mr William Dick, in 1818, who, after five years of unrequited labour, fortunately for himself and the progress of the veterinary science in Scotland, obtained the patronage of the Highland and Agricultural Society of Scotland, who have afforded him a small salary since 1823. Since then the success of his exertions have been extraordinary, not fewer than from seventy to one hundred pupils attending the college every session, of whom about twenty every year, after at least two years' study of practical anatomy and medicine, become candidates for the diploma of veterinary surgeon. Their qualifications are judged of after an examination by the most eminent medical practitioners in Edinburgh. The students enjoy free admission to the lectures on human anatomy and physiology in Queen's College by the liberality of its professors. Through the influence of the Highland Society, permission has been obtained for the graduates to enter as veterinary surgeons into her Majesty's cavalry regiments, as well as those of the Honourable East India Company.

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* Beauties of England and Wales, vol. x. Part IV., p. 181.

In recommending farmers to attend lectures on veterinary science, it must not be imagined that I wish them to become veterinary surgeons. Let every class of people adhere to their own profession. But there is no doubt that a knowledge of veterinary science is of great use to the farmer, not in enabling him to administer to the diseased necessities of his live-stock, for that requires more professional skill and experience than any farmer can attain to, and is the proper province of the regularly bred veterinary surgeon; but to enable him readily to detect a disease by its symptoms, in order to apply immediate checks to its progress until he can communicate with and inform the veterinary surgeon of the nature of the complaint, whereby he may bring with him materials for treating it correctly on his arrival. The death of a single animal may be a serious loss to the farmer, and if, by his knowledge of the *principles* of the veterinary art, he can stay the progress of any disease, he may not only avert the loss, but prevent his animal being much affected by disease. Disease, even when not fatal to animals, leaves injurious effects on their constitutions for a long time.

With regard to attending lectures on agriculture, I should say, from my own experience, that more benefit will be derived from attending them after having acquired a practical knowledge of husbandry than before; because many of the details of farming cannot be comprehended, unless the descriptions of them are given where the operations themselves can be referred to.

Abroad are several institutions for the instruction of young men in agriculture, among which is the far-famed establishment of Hofwyl, in the canton of Berne, in Switzerland, belonging to M. de Fellenberg. This establishment is not intended so much for a school of agriculture, as that of education and moral discipline. All the pupils are obliged to remain nine years, at least until they attain the age of twenty-one, during which time they undergo a strict moral discipline, such as the inculcation of habits of industry, frugality, veracity, docility, and mutual kindness, by means of good example rather than precepts, and chiefly by the absence of all bad example. The pupils are divided into the higher and lower orders, among the former of whom may be found members of the richest families in Germany, Russia, and Italy. For these the course of study is divided into three periods of three years each. In the first, they study Greek, Grecian history, and the knowledge of animals, plants, and minerals; in the second, Latin, Roman history, and the geography of the Roman world; and in the third, modern languages and literature, modern history to the last century, geography, the physical sciences, and chemistry. During the whole nine years they apply themselves to mathematics, drawing, music, and gymnastic exercises. The pupils of the canton of Berne only pay M. de Fellenberg 45 louis each, and do not cost their parents above 100 louis or 120 louis a-year. Strangers pay him 125 louis, including board, clothing, washing, and masters.

The pupils of the lower orders are divided into three classes according to their age and strength. The first get a lesson of half an hour in the morning, then breakfast, and afterwards go to the farm to work. They return at noon. Dinner takes them half an hour, and after another lesson of one hour, they go again to work on the farm until six in the evening. This is their summer occupation; and in winter they plait straw for chairs, make baskets, saw logs and split them, thrash and winnow corn, grind colours, knit stockings: for all of which different sorts of labour, an adequate salary is credited to each boy's class until they are ready to leave the establishment. Such as have a turn for any of the trades in demand at Hofwyl, wheelwright, carpenter, smith, tailor, or shoemaker, are allowed to apply to them. Thus the labour of the field, their various sports, their lessons, their choral songs, and necessary rest, fill the whole circle of the twenty-four hours; and judging from their open, cheerful, contented countenances, nothing seems wanting to their happiness.

It is admitted that, on leaving the establishment, the pupils of the higher classes, are eminently moral and amiable in their deportment, that they are very intelligent, and that their ideas have a wide range; and though they may not be so advanced in science as some young men brought up elsewhere, they are as much so as becomes liberal-minded gentlemen, though not professors. The pupils of the lower classes leave at the age of twenty-one, understanding agriculture better than any peasants ever did before, besides being practically acquainted with a trade, and with a share of learning quite unprecedented among the same class of people; and yet as hard-working and abstemious as any of them, and with the best moral habits and principles. It seems impossible to desire or imagine a better condition of peasantry.

As all the instruction at this establishment is conveyed orally, a great many teachers are required in proportion to the number of the pupils. In 1819, there were thirty professors for eighty pupils. This entails a considerable expense upon M. de Fellenberg, who besides extends the erection of buildings as he finds them necessary. He is, however, upon the whole, no loser by the speculation. Each pupil of the lower orders costs him L.56 a-year to maintain and educate, which is L.3, 8s. a-year beyond the value of his work, and yet the investment is a profitable one, yielding something more than $8\frac{1}{4}$ per cent. interest, net of all charges. "The farm is undoubtedly benefited by the institution, which affords a ready market for its produce, and perhaps by the low price at which the labour of the boys is charged. But the farm, on the other hand, affords regular employment to the boys, and also enables M. de Fellenberg to receive his richer pupils at a lower price than he could otherwise do. Hofwyl, in short, is a great whole, where one hundred and twenty or one hundred and thirty pupils, more than fifty masters and professors, as many servants, and a number of day-labourers, six or eight families of artificers and tradesmen, altogether about three hundred persons, find a plentiful, and in many respects a luxurious subsistence, exclusive of education, out of a produce of one hundred and seventy* acres ; and a money income of L.6000 or L.7000, reduced more than half by salaries, affords a very considerable surplus to lay out in additional buildings."† It seems that, since 1807, two convents, one in the canton of Fribourg, and the other in that of Thurgovie, have formed establishments analogous to those of M. de Fellenberg.‡

The celebrated German institution for teaching agriculture is at Möeglin, near Frankfort on the Oder. It is under the direction of M. Von Thäer. There are three professors besides himself; one for mathematics, chemistry, and geology ; one for veterinary knowledge ; and a third for botany, and the use of the different vegetable productions in the materia medica, as well as for entomology. Besides these, an experienced agriculturist is engaged, whose office it is to point out to the pupils the mode of applying the sciences to the practical business of husbandry. Such a person would be difficult to be found in this country. The course commences in *September*, the best season in my opinion for commencing the learning of agriculture. During the winter months the time is occupied in mathematics, and in the summer the geometrical knowledge is practically applied to the measurement of land, timber, buildings, and other objects. The first principles of chemistry are unfolded. Much attention is paid to the analysation of soils. There is a large botanic garden, with a museum containing models of implements of husbandry. The various implements used on the farm are all made by smiths, wheelwrights, and carpenters, residing round the institution ; the workshops are open to the pupils, and they are encouraged by attentive inspection to become masters of the more minute branches of the economy of an estate.

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* This is the number of acres in the farm as stated in the Edinburgh Review for October 1819 ; but a correspondent in Hull's Philanthropic Repertory for 1832, makes it 250 acres.

† Edinburgh Review, No. 64.

‡ Ebel, Manuel du Voyageur en Suisse, tome ii.

As the sum paid by each pupil, who are from twenty to twenty-four years of age, is 400 rix-dollars annually (equal to about L.60 Sterling, if the rix-dollar is of Prussian currency), and besides which they provide their own beds and breakfasts, none but youths of good fortune can attend at Möeglin. Each has a separate apartment. They are very well behaved young men, and their conduct to each other, and to the professors, is polite even to punctilio.

The estate of Möeglin consists of twelve hundred English acres. About thirty years ago it was given in charge by the King of Prussia to M. Von Thäer, who at that time was residing as a physician at Celle, near Luneburg, in Hanover, with the view of diffusing agricultural knowledge in Prussia, which it was known M. Von Thäer possessed in an eminent degree, as evinced by the translations of numerous agricultural works from the English and French, by his management in setting an example to the other great landed proprietors, and stimulating them to adopt similar improvements. His Majesty also wished him to conduct a seminary, in which the knowledge of the sciences might be applied to husbandry, for the instruction of the young men of the first families. When M. Von Thäer undertook the management of this estate, its rental was only 2000 rix-dollars a-year (L.300), and twenty years ago, the rental had increased to 12,000 rix-dollars (L.1800). This increased value, besides the buildings erected, has arisen from the large flocks of sheep which in summer are folded on the land, and in winter make abundant manure in houses constructed for their lodging.

These particulars are taken from Mr Jacob's travels, who visited Möeglin in 1819, and who, in considering of the utility of such an institution in this country, makes these remarks on the personal accomplishments of M. Von Thäer. "We have already carried the division of labour into our agriculture, not certainly so far as it is capable of being carried, but much farther than is done in any other country. We have some of the best sheep farmers; of the best cattle and horse breeders; of the best hay, turnip, potato, and corn farmers in the world; but we have perhaps no one individual that unites in his own person so much knowledge of chemistry, of botany, of mathematics, of comparative anatomy, and of the application of these various sciences to *all* the practical purposes of agriculture as Von Thäer does; nor is the want felt, because we have numbers of individuals, who, by applying to each branch separately, have reached a height of knowledge far beyond what any man can attain who divides his attention between several objects. In chemistry we have now most decidedly the lead. In all of botany that is not mere nomenclature, it is the same. In mechanics we have no equals. There are thus abundant resources, from which practical lessons may be drawn, and be drawn to the greatest advantage; and that advantage has excited, and will continue to excite, many individuals to draw their practical lessons for each particular branch of agriculture, from that particular science on which it depends; and thus the whole nation will become more benefited by such divisions and subdivisions of knowledge, than by a slight tincture of all the sciences united in the possession of some individuals."[*]

France also possesses institutions for the teaching of agriculture. The first was that model farm at Roville, near Nancy, founded by M. Mathieu de Dombasle.[†] Though it is acknowledged that this farm has done service to the agriculture of France, its situation being so far removed from the centre of that country, its influence does not extend with sufficient rapidity. Its limited capital does not permit the addition of schools, which are considered necessary for the instruction of young proprietors who wish to manage their own properties with advantage, and of agents capable of following faithfully the rules of good husbandry.

To obviate the disadvantages apparent in the institution of Roville, "a number of men distinguished for their learning and zeal for the prosperity of France, and convinced of the utility of the project, used means to form an association of the nature of a joint-stock company, with 500 shares of 1200 francs each, forming a capital of 600,000 francs (L.25,000). The first half of this sum was devoted to the advancement of superior culture, and the second half to the establishment of two schools, one for pupils, who, having received a good education, wish to learn the theory and the application of agriculture, and of the various arts to which it is applicable; and the other for children without fortune, destined to become labourers, instructed as good ploughmen, gardeners, and shepherds, worthy of confidence being placed in them."[‡] This society began its labours in 1826 by purchasing the domain of Grignon, near Versailles, in the valley of Gally, in the commune of Thiverval, and appointing M. Bella, a military officer who had gained much agricultural information from M. Von Thäer, during two years' sojourn with his corps at Celle. M. Bella travelled through France, in the summer of 1826, to ascertain the various modes of culture followed in the different communes. Grignon was bought in the name of the king, Charles X., who attached it to his domain, and gave the society the title of the Royal Agricultural Society for a period of forty years. The statutes of the society were approved of by royal ordonance on the 23d May 1827, and a council of administration was named from the list of shareholders, consisting of a president, two vice-presidents, a secretary, a treasurer, and directors.

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[*] Jacob's Travels in Germany, &c. pp. 173-188.

[†] Annales de Roville.

[‡] Rapport General sur la ferme de Grignon, Juin 1828, p. 3.

The domain, which occupies the bottom and the two sides of the valley, in length 2254 metres (a metre being equal to 3 feet and 11½ lines), is divided into two principal parts; the one is composed of a park of 290 hectares (387 acres), inclosed with a stone wall, containing the mansion-house and its dependencies, the piece of water, the trees, the gardens, and the land appropriated to the farm; the other, called the outer farm, is composed of 176 hectares (234 acres), of unenclosed land, to the south of the park.

With regard to the nature of the schools at Grignon, this account has been published,—" The council of administration being occupied in the organization of regular schools, has judged that it would be convenient and useful to open, in 1829, a school for work-people, into which to admit boys of from twelve to sixteen years of age, to teach them reading, writing, arithmetic, and the primary elements of the practice of geometry. The classes to meet two hours every day in summer, and four hours in winter, the rest of the time to be employed in manual work. The fee to be 300 francs the first year, 200 francs the second, and 100 francs the third. After three years of tuition the fee to cease, when an account is to be opened to ascertain the value of their work against the cost of their maintenance, and the balance to go to form a sum for them when they ultimately leave the institution."

" Meanwhile, as the director has received several applications for the admission of young men, who, having received a good education, are desirous of being instructed in agriculture, the council has authorized the conditional admission of six pupils. But as there are yet no professors, the pupils who are at present at Grignon can only actually receive a part of the instruction which it is intended to be given. They every day receive lessons from the director on the theory of agriculture, besides lessons on the veterinary art, and the elements of botany, from the part of the veterinary school attached to the establishment; also lessons of the art of managing trees and making plantations, given by a forester of the crown forests, and some notions of gardening by the gardener. During the rest of the time, they follow the agricultural labours and other operations of the establishment. They pay 100 francs a-month, including bed, board, and washing.

"Several proprietors who occupy farms, having expressed a desire to see young farm-servants taught the use of superior implements, and the regular service on a farm, the director has admitted a few, lessening the fee to the payment of board and lodging. There are two just now. To such are given the name of "farm pupils."*

The course of education proposed to be adopted at Grignon, is divided into theoretical and practical. The course to continue for two years. In the first year to be taught mathematics, topography, physics, chemistry, botany and botanical physiology, veterinary science, the principles of culture, the principles of rural economy applied to the employment of capital, and the interior administration of farms. The second year to comprehend the principles of culture in the special application to the art of producing and using products; the mathematics applied to mechanics, hydraulics, and astronomy; physics and chemistry applied to the analysis of various objects; mineralogy and geology applied to agriculture; gardening, rural architecture, legislation in reference to rural properties, and the principles of health as applicable both to man and beast.

There are two classes of pupils, free and internal. Any one may be admitted a free pupil that has not attained twenty years of age, and every free pupil to have a private chamber. The pupils of the interior must be at least fifteen years of age.

The fee of the free pupils is 1500 francs a-year; that of the pupils of the interior 1300 francs. They are lodged in the dormitories in box-beds; those who desire private apartments pay 300 francs more, exclusive of furniture, which is at the cost of the pupils.†

There is an agricultural school at Hohenheim, in the Duchy of Wirtemberg, and another at Flottbeck in Flanders, belonging to M. Voght. An account of both these institutions is given by M. Bella, in the third number of the Annals of Grignon. There are, I understand, schools of agriculture, both in St Petersburgh and Moscow, but have not been so fortunate as to meet with any account of them.

It appears to me, from the best consideration I can give to the manner in which agriculture is taught at these schools, that as means of imparting real practical knowledge to pupils, they are inferior to the usual mode adopted in this country, of living with farmers. In reference to the results of the education obtained at Möeglin, Mr Jacob says—"It

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[*] Annales de Grignon, 2d livraison, 1829, p. 48.

[†] Annales de Grignon, 3d livraison, 1830, p. 108.

appeared to me that there was an attempt to crowd too much instruction into too short a compass, for many of the pupils spend but one year in the institution, and thus only the foundation, and that a very slight one, can be laid in so short a space of time. It is however to be presumed, that the young men come here prepared with considerable previous knowledge, as they are mostly between the ages of twenty and twenty-four, and some few appeared to be still older."*

Although the pupils are kept at Hofwyl for nine years, and are fined if they leave it sooner, it is obvious that the higher class of them bestow but little attention on farming, and most on classical literature. And the particulars given in the elaborate programme of the school of agriculture at Grignon, clearly evince that attention to minute discipline, such as marking down results, and to what are termed *principles*, which just mean vague theorizings, form a more important feature of tuition than the practice of husbandry. The working pupils may acquire some knowledge of practice by dint of participating in work, but the other class can derive very little benefit from all the practice they see.

7. OF THE EVILS ATTENDANT ON LANDOWNERS NEGLECTING TO LEARN PRACTICAL AGRICULTURE.

> " ——— leaving me no sign,—
> Save men's opinions, and my living blood,—
> To shew the world I am a gentleman."
>
> RICHARD II.

There would be no want of pupils of the highest class for institutions such as I have recommended for promoting agricultural education, did landed proprietors study their true interests, and learn practical agriculture. Besides the usual succession of young farmers to fill the places of those who retire, and these of themselves would afford the largest proportion of the pupils, were every son of a landowner, who has the most distant prospect of being a landed proprietor himself, to become an agricultural pupil, in order to qualify himself to fulfil *all* the onerous duties of his station, when required to occupy that important position in the country, that class of pupils would not only be raised in respectability, but the character of landed proprietors, as agriculturists, would also be much elevated. The expectant landlord should therefore undergo that tuition, though he may intend to follow, or may have already followed, any other profession. The camp and the bar seem to be the especial favourite arenas upon which the young scions of the gentry are desirous of displaying their first acquirements. These professions are highly honourable, none more so, and they are, no doubt, conducive to the formation of the character of the gentleman; but, after all, are seldom followed out by the young squire. The moment he attains rank above a subaltern, or dons his gown and wig, he quits the public service, and assumes the functions of an incipient country gentleman. In the country he becomes at first enamoured of field sports, and the social qualities of sportsmen. Should these prove too rough for his taste, he travels abroad peradventure in search of sights, or to penetrate more deeply into the human breast. Now, all the while he is pursuing this course of life, quite unexceptionable in itself, he is neglecting a most important part of his duty,—that of learning to become a good landlord. On the other hand, though he devote himself to the profession of arms or the law, either of which may confer distinction on its votaries; yet if either be preferred by him to agriculture, he is doing much to unfit himself from being an influential landlord. To become a soldier or a lawyer, he willingly undergoes initiatory drillings and examinations; but, to become a landlord, he considers it quite unnecessary, to judge by his conduct, to undergo any initiatory tuition. That is a business, he conceives, that can be learned at any time, and seems to forget that it is *his* profession, and does not consider that it is one as difficult of thorough attainment as ordinary soldiership or legal lore. No doubt, the army is an excellent school for confirming, in the young, principles of honour and habits of discipline; and the bar for giving clear insight into the principles upon which the rights of property are based, and into the true theory of the relation betwixt landlord and tenant; but whilst these matters may be attained, a knowledge of agriculture, the weightiest matter to a landlord, should not be neglected. The laws of honour and discipline are now well understood, and no army is required to inculcate their acceptableness on good society. A knowledge of law, to be made applicable to the occurrences of a country life, must be *matured by long experience*; for, perhaps, no sort of knowledge is so apt to render landed proprietors litigious and uncompromising with their tenants, as a smattering of law. Instances have come under my own notice, of the injurious propensities which a slight acquaintance with law engenders in landed proprietors, as exhibited on their own estates, and at county and parochial meetings. No class of persons require Pope's admonition regarding the evil tendency of a "little learning" to be more strongly inculcated on them, than the young barrister who doffs his legal garments, to assume in ignorance the part of the country squire :

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* Jacob's Travels in Germany, &c. p. 185.

> " A little learning is a dangerous thing !
> Drink deep, or taste not the Pierian spring ;
> There shallow draughts intoxicate the brain."

I do not assert that a knowledge of military tactics, or of law, is inconsistent with agriculture. On the contrary, a *competent* knowledge of either, and particularly of the latter, confers a value on the character of a country gentleman versant with agriculture ; but what I do assert most strongly is, that the most intimate acquaintance with either, will never serve as a substitute for ignorance of agriculture in a country gentleman.

One evil arising from studying those exciting professions before agriculture is, that, however short the time spent in acquiring them, it is sufficiently long to create a distaste to learning agriculture practically, for such a task can only be undertaken, after the turn of life, by enthusiastic minds. But as farming is necessarily *the profession* of the country gentleman, for all *have* a farm, it should be learned, theoretically and practically, before his education should be considered finished. If he so incline, he can afterwards enter the tented field, or exercise his forensic eloquence, when the tendency which I have noticed in these professions will be unable to efface the knowledge of agriculture previously acquired. This is the proper course for every young man destined to become a landed proprietor to pursue, and who wishes to be otherwise employed as long as he cannot exercise the functions of a landlord. Were this course always pursued, the numerous engaging ties which a country life never fails to form, rendered more interesting by a knowledge of agriculture, would tend to extinguish the kindling desire for any other profession. Such a result would be most desirable for the country ; for only contemplate the effects of the course pursued at present by landowners. Does it not strike every one as an incongruity for a country gentleman to be unacquainted with country affairs ? Is it not "passing strange" that he should require inducements to learn his hereditary profession,—to know a business which alone can enable him to maintain the value of his estate, and secure his income ? Does it not infer a species of infatuation to neglect becoming well acquainted with the true relation he stands to his tenants, and by which, if he did, he might confer happiness on many families ; but to violate which, he might entail lasting misery on many more ? In this way the moral obligations of the country gentleman are too frequently neglected. And no wonder, for these cannot be perfectly understood, or practised aright, but by tuition in early life, or by very diligent and irksome study in maturer years. And no wonder that great professional mistakes are frequently committed by proprietors of land. Descending from generalities to particulars, it would be no easy task to describe all the evils attendant on the neglect of farming by landowners; for though some are obvious enough, others can only be morally discerned.

1. One of the most obvious of those evils is, when country gentlemen take a prominent share in discussions on public measures connected with agriculture, and which, from the position they occupy, they are frequently called upon to do, it may be remarked that their speeches are usually introduced with apologies for not having sufficiently attended to agricultural matters. The avowal is candid, but it is any thing but creditable to the position they hold in the agricultural commonwealth. When, moreover, it is their lot or ambition to be elected members of the legislature, it is deplorable to find so many so little acquainted with the questions which bear directly or indirectly on agriculture. On these accounts, the tenantry are left to fight their own battles on public questions. Were landowners practically acquainted with agriculture, such painful avowals would be spared, as a familiar acquaintance with it enables the man of cultivated mind at once to perceive its practical bearing on most public questions.

2. A still greater evil consists in their consigning the management of valuable estates to the care of men as little acquainted as themselves with practical agriculture. A factor or agent, in such a condition, always affects much zeal for the interest of his employer; but it is "a zeal not according to knowledge." Fired by this zeal, and undirected as it most probably is by sound judgment, he soon discovers something at fault among the poorer tenants. The rent perhaps is somewhat in arrear,—the strict terms of the lease have been deviated from,—things appear to him to be going down hill. These are fruitful topics of contention. Instead of being "kindly affectioned," and thereby willing to interpret the terms of the lease in a generous spirit, the factor hints that the rent must be better secured, through the means of another tenant. Explanation of circumstances affecting the condition of the farmer, over which he has perhaps no control,—the inapplicability, perhaps, of the peculiar covenants of the lease to the particular circumstances of the farm,—the lease having perhaps been drawn up by himself, or some one as ignorant as himself,—are excuses unavailingly offered to one who is confessedly unacquainted with country affairs, and the result ensues in interminable disputes betwixt him and the tenants. With these the landlord is *unwilling* to interfere, in order to preserve intact the authority of the fac-

tor; or, what is still worse, is *unable* to interfere, because of his own unacquaintance with the actual relations subsisting betwixt himself and his tenants, and, of course, the settlement is left with the originator of the disputes. Hence originate actions at law,—criminations and recriminations,—much alienation of feeling; and at length a settlement of matters, at best perhaps unimportant, is left to the arbitration of practical men;—in making which submission, the factor acknowledges as much as he himself was unable to settle the dispute. The tenants are glad to submit to arbitration to save their money. In all such disputes, they, being the weaker parties, suffer most in purse and character. The landlord, who should have been the natural protector, is thus converted into the unconscious oppressor, of his tenants. This is confessedly an instance of a bad factor; but have such instances of oppression never occurred, and from the same cause, that of ignorance in both landlord and factor?

A factor acquainted with practical agriculture would conduct himself very differently in the same circumstances. He would endeavour to prevent legitimate differences of opinion on points of management terminating into disputes, by skilful investigation and well-timed compromise. He studies to uphold the honour of both landlord and tenants. He can see whether the terms of the lease are strictly applicable to prevailing circumstances, and judging thereby, checks every improper deviation from appropriate covenants, whilst he makes ample allowance for unforeseen contingencies. He can discover whether the condition of the tenants is influenced more by their own doings, than by the nature of the farms they occupy. He regulates his conduct towards them accordingly; encouraging the industrious and skilful, admonishing the indolent, and amending the unfavourable circumstances of the farms. Such a man is highly respected, and his opinion and judgment are greatly confided in by the tenantry. Mutual kindliness of intercourse always subsists betwixt them. No landlord, whether himself acquainted or unacquainted with farming, but especially the latter, should confide the management of his estate to any other kind of factor.

3. Another obvious evil is one which affects the landed proprietor's own comfort and interest, and which is the selection of a steward or grieve for conducting the home-farm. In all cases it is necessary for a landowner to have a home-farm, and to have a steward to conduct it. But the steward of a squire acquainted and unacquainted with farming, is placed in very dissimilar circumstances. The steward of a squire acquainted with farming, enjoying good wages, and holding a respectable and responsible situation, *must* conduct himself as an honest and skilful manager, for he

knows he is superintended by one who can criticise his management well. A steward in the other position alluded to, must necessarily have, and will soon take care to have, every thing his own way. He soon becomes proud in his new charge, because he is in the service of a squire. He soon displays a haughty bearing, because he knows he is the only person on the farm who knows any thing about his business. He becomes overbearing to the rest of the servants, because, in virtue of his office, he is appointed purveyor to the entire establishment; and he knows he can starve the garrison into a surrender whenever he pleases. He domineers over the inferior work-people, because, dispensing weekly wages, he is the custodier of a little cash. Thus advancing in his own estimation step by step, and finding the most implicit reliance placed in him by his master, who considers his services as invaluable, the temptations of office prove too powerful for his virtue, he aggrandizes himself, and conceals his mal-practices by deception. At length his peculations are detected by perhaps some trivial event, the insignificance of which had escaped his watchfulness. Then loss of character and loss of place overtake him at once. Such flagrant instances of unworthy factors and stewards of country gentlemen are not supposititious. I could specify instances of both, whose mismanagement has come under my own observation. Both species of pests are engendered from the same cause,—the ignorance of landowners in country affairs.

4. Another injurious effect it produces, is absenteeism. When farming possesses no charms to the country gentleman, and field-sports become irksome by monotonous repetition, his taste for a country life declines, and to escape *ennui* at home, he banishes himself abroad. If such lukewarm landed proprietors, when they go abroad, would always confide the management of their estates to unexceptionable factors, their absence would be little felt by the tenants, who would proceed with the substantial improvement of their farms with greater zest under the countenance of a sensible factor, than of a landlord who contemns a knowledge of agriculture. But it must be admitted, that tenants farm with much greater *confidence* under a landlord acquainted with farming, who is always at home, than under the most unexceptionable factor. The disadvantages of absenteeism are only felt by tenants left in charge of a litigious factor, and it is always severely felt by day-labourers, tradesmen, and shopkeepers in villages and small country towns.

Now, all these evils—for evils they certainly are—and many more I have not touched upon, would be avoided, if landowners would make it a point to acquire a knowledge of practical agriculture. This can best be done in youth, when it should be studied as a *necessary* branch of education, and learned as the most *useful* business which country gentlemen can know. It will qualify them to appoint competent factors,—to determine upon the terms of the lease most suited to the nature of each of the farms on their properties,—and to select the fittest tenants for them. This qualification could not fail to inspire in tenants confidence in their landlords, by which they will be encouraged to cultivate their farms in the best manner for the land and for themselves, in even the most trying vicissitudes of seasons; and without which confidence the land, especially on estates on which no leases are granted, would never be cultivated with spirit. It confers on landlords the power to judge for themselves of the proper fulfilment of the onerous and multifarious duties of a factor. It enables them to converse freely in technical terms with their tenants on the usual courses of practice, to criticise work, and to predicate the probability of success or failure of any proposed course of culture. The reproving or approving remarks of such landlords operate powerfully with tenants. How many useful hints is it at all times in the power of such landlords to suggest to their tenants, on skilfulness, economy, and neatness of work; and how many salutary precepts may they inculcate on cottagers, on the beneficial effects of parental discipline and domestic cleanliness! The degree of good which the direct moral influence of such landlords among their tenantry can effect, can scarcely be over-estimated; its primary effect being to secure respect, and create regard. The good opinion, too, of a judicious factor is highly estimated by the tenantry; but the discriminating observations of a practical and well disposed landlord go much farther in inducing tenants to maintain their farms in the highest order, and to cherish a desire to remain on them from generation to generation. Were all landlords so actuated—and acquaintance with farming would certainly prompt them thus to act—they could at all times command the services of superior factors and skilful tenants.

They would then find there is not a more pleasing, rational, and interesting study than practical agriculture; and soon discover that to know the minutiæ of farming is just to create an increasing interest in every farm operation. In applying this knowledge to practice, they would soon find it operate beneficially for their estates, by the removal of objects which offend the eye or taste, and the introduction of others that would afford shelter, promote improvement, and contribute to the beauty of the landscape of the country around. Nor would these rural pursuits be inconsistent with the exercise of those manly field-sports, in which it is the pride and boast of our country gentlemen to excel. Hunting is prosecuted with the greatest ardour in the season in which field operations are least practised, and crops can sustain the least injury. The tenantry feel great interest in the chase, many personally participate in it, and all wish it success. There is, perhaps, no single adventitious circumstance that establishes so cordial a feeling betwixt landlords and tenants in a district, as the common interest excited by fox-hunting. In prosecution of the exhilarating sport, land-owners and farmers associate together at the *meets;* or the former may fall in with the latter in a *burst* through their farms, when the hounds are in full *cry*, the scent *breast* high, and when at a *killing pace* the most experienced *fencer*, or the most *knowing one* of the *lie of the country*, will not blink a gate thrown open for him, or despise a hint to a gap in the hedge. Sportsmen know full well how much is in the power of farmers to render their sport agreeable or otherwise.

> " All now is free as air, and the gay pack
> In the rough bristly stubbles range unblam'd.
> No widow's tears o'erflow, no secret curse
> Swells in the farmer's breast, which his pale lips
> Trembling conceal, by his fierce landlord aw'd :
> But courteous now, he levels every fence,
> Joins in the common cry, and haloos loud,
> Charm'd with the rattling thunder of the field."*

Agricultural Shows afford another and a different sort of opportunity for landlords and tenants to meet. They are the most important, and at the same time the most social meetings that are held in the country; and they are now conducted on such well recognised principles, that, though all classes of persons appear at them on the same footing, the respect due to rank and station is never lost sight of.

A personal acquaintance with tenants of all classes presents to landlords a wide field for the observation of human nature under different circumstances. Coupling the observations derived from so extensive and varied a field with their own experience of practical agriculture, landowners possess peculiar advantages for collecting a store of facts, from which to be supplied with the most cogent arguments and illustrations, in every department of rural economy, and the right use of which would cause their sentiments to command attention in every public assembly in which they chose to give them utterance.

It appears extraordinary to those who have felt the difficulty of acquiring a competent knowledge of country affairs, to observe landowners, who have spent their time in learning every thing else but that, coolly undertaking to perform, without previous preparation, all the functions of country gentlemen. Granting that they are entitled to the privilege by hereditary birth, what, I would ask, would be thought of the presumption of a subaltern, who pretended to assume the command of an army, or of a student of law, to conduct an important cause before the highest tribunal? True, to command an army, or to plead a great cause, requires a higher degree of intellectual acumen, than the performance of the functions of a country gentleman in the most perfect manner. Yet, taking the most out of this admission, it is surely not intended to be maintained, that the functions of landownership may be well enough exercised without previous study, any more than to command or to plead requires no experience? Landowners, no doubt, can enjoy their incomes, in a way suitable to their tastes, without knowing any thing of agriculture, whereas the incomes derived from the army and the bar, can only be enjoyed as the rewards of service; but surely the privileges on possessing land by inheritance were bestowed by law for far higher purposes than merely expending the income derived from it. The *quid pro quo* for the privileges of inheritance is the performance of certain onerous duties. Did the privileges only imply the right of spending incomes abroad, it would be matter of little importance whether landowners understood agriculture or no; but when residing on their estates, they profess to exercise a hereditary and paternal superintendence over them,—claim a seat on the magisterial bench,—take a share in all public affairs connected with agriculture and the interests of landed property, in and out of the legislature,—it cannot be unreasonable to expect them to be endued with the attributes of the character they have assumed.

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* Somerville.

No doubt, landowners, unacquainted with agriculture, may content their minds with the assurance, that their estates are well farmed by skilful tenants,—well managed by competent factors,—and their incomes undoubtedly secured; but how do they know, who are themselves unacquainted with rural affairs, when their estates *are* well farmed, and well managed, and their incomes secured beyond a doubt? It is no infallible proof of estates being either well farmed, or well managed, to draw the rents therefrom without abatement; for rents may have been fixed at sums below their intrinsic value; or they may have been fixed unequally, in respect to relative value, whereby the excess of some rents may make good the deficiencies of others; or factors may maintain the nominal amount of rentals by annual sales of timber, stone, or other commodities which the estates may most amply afford; or all these circumstances may combine to maintain the rentals of estates; but of the correct influence of these circumstances landlords unacquainted with farming are incompetent to judge, and far less able to make comparisons of the value of their own estates with those which are under the immediate superintendence of practical landlords. Such a system of management may proceed well enough in prosperous times; but let a change occur, political or social, materially affecting agriculture, let a period of low prices prevail, or a series of bad crops diminish the capital of the tenants, and render them unable to pay their stipulated rents, and then let landlords unacquainted with rural affairs contemplate the effects of such contingencies on their incomes. How should they act under the circumstances? *They* know not. Practical landlords know at once the manner and the extent in which they should conform to the exigencies of the times; and factors under them find it a comparatively easy matter to adjust new arrangements with the tenants; and the tenants, confiding in the judgment of both, accept the well considered terms without hesitation. Inexperienced landlords, on the other hand, conduct themselves very differently in trying circumstances. Having no well founded notion of the principles which regulate the value of land, whenever a reduction of rent is demanded by the tenants, in conformity with the uncontrollably altered state of things, they have no data previously stored in their minds by which to regulate the rate of reduction; but being made aware by the factor that a reduction should be made,—more to secure the occupancy of the farms, than to maintain the solvency of the tenants,—a small per-centage is reluctantly assented to for a time, irrespective of the merits of the case of each particular farm. A settlement of affairs is thus accomplished for a season, which is most probably inapplicable to the next, when the same unpleasant business has to be negociated, or the demand for reduction peremptorily refused. Hence arises discontent; and, erewhile, the land suffers from the inability of some, and the unwillingness of the rest of the tenants, to maintain its fertility, on account of the uncertainty of their ability to retain their farms, in consequence of the distrust shewn to their representations by their landlords, and evinced by the refusal to meet their necessitous wishes in a generous spirit. No policy can be more injurious to the character of landlords than this. Ignorance, with subserviency to their factor, will be imputed to them. Were they to meet well-grounded complaints in a generous spirit, the tenants would be easily satisfied, and suffer considerable privations before they could be prevailed upon to renew them. Because they know they have bargained in specific terms with their landlords, and that they ought to fulfil their obligations as well in adverse as in prosperous times, and they are conscious that if those obligations were strictly attended to, there would be fewer occasions of collision betwixt them and their landlords. They thus feel their dependence. These are just sentiments of theory, but cannot always be maintained in practice; because many tenants, in adverse times, do not possess the means of liquidating every instant demand upon them, including rent, though their stocking may be of far greater value than the whole amount of those demands, yet, to touch upon *that* for the purpose of rent, would not only derange the economy of the farm, but ultimately injure the landlord's own interest, by neglecting the culture of the land, and depreciating its value.

> " The sweat of industry would dry, and die,
> But for the end it works to.——"

To avert so great an evil, the effects of which may be felt over the whole succeeding lease, landlords should grant such a reduction of rent at once, as will enable industrious tenants to carry on their farms to the best advantage in the altered circumstances of the times. Nor is a large reduction of rent devoid of justice; for, in prosperous times, most tenants are not in the habit of hoarding money on ordinary leases, and therefore cannot long endure adversity; and if, after bringing up their families, and providing for them, they should have earned a little spare capital, it is usually expended in prosecuting farther improvements, if required, or in extending their operations by taking other farms.

Whilst such negociations are carrying on, the factor is placed in a delicate situation. Let him be ever so well disposed towards the tenantry, he cannot convince an inexperienced landlord of the advantage of submitting to a large reduction of rent at once, rather than undergo the disagreeable task of arguing upon and yielding a petty reduction every year. Let him plead for the tenants with all the earnestness of a sympathising heart, and the force of indisputable facts, it will prove unavailing on a mind inexperienced of those facts; and in urging their case farther than the humour of the landlord will bear, he may jeopardise his own livelihood, and the case being so, his interest would rather prompt him to flatter the landlord's cupidity, than alleviate the tenant's hardships. Could the landlord be shewn that his own interest is involved in that of his tenants, there might be some hope of an equitable negociation, but to the inexperienced in country matters, how hard would be the conviction that decrease of income may promote increase of safety. Were the factor really ill-disposed to the tenants, what a glorious opportunity would such a time afford him of avenging himself upon them, by hardening the heart of the landlord against any concession, on the bare plea of inexpediency.

No doubt, landlords, though unacquainted with farming, may have their properties well managed by judicious factors, and were *implicit* reliance always placed in them, by landlords and tenants, those properties would thrive apace. But, tenants, as I have before said, always feel greater confidence under the immediate cognizance of a practical landlord, than under any factor ; for, besides the question of rent, which may have to be discussed oftener than once in the currency of a lease, there are many links of attachment which bind a landlord with his tenants, that cannot subsist betwixt them and the factor. The position of tenants on very large estates, it is true, is somewhat different. Great landowners cannot be expected to become personally known to every one of their numerous tenants, even though they may be thoroughly versed in practical agriculture ; and this being necessarily the case, their factors, in every portion of their estates, are endued with almost as large discretionary powers as proprietors themselves, in so far, at least, as the tenants are concerned. Still it is desirable for the most satisfactory management of even the largest estates, that landowners of the largest extent, and highest titles, should be acquainted with practical farming. Bacon says, " It is no baseness for the greatest to descend and look into their own estate." For this purpose, they should themselves be able to examine the qualifications of factors, however highly recommended they may be by testimonials. A few questions, put with the discernment which practice never fails to confer on the practical man, give a clearer insight into the actual qualifications of a factor than volumes of testimonials. The choosing of good factors is an important matter in the welfare of every estate, and much more so on one of such an extent as to preclude the possibility of the personal superintendence of the landlord himself. Practical knowledge also enables landlords at once to direct their observation to those minute circumstances which are infallible indications of land being well or ill farmed. This faculty of minute observation is invaluable to landlords and factors, in enabling them to judge of the condition of land without much trouble, and it may be easily acquired with a previous knowledge of the minutiæ of farming. The accomplishment of matured observation is well worth the landlord's while bestowing some pains to acquire.

There is also no doubt, that tenants in similar circumstances with respect to their farms, may cultivate them as well under a landlord unacquainted, as acquainted with farming. Any difficulty the tenants may have to contend with, consists not so much in the cultivation of their farms, as in obtaining similar advantages of lease from the inexperienced, as from the experienced landlord ; and although as great advantages were obtained at the commencement of the lease, yet occurrences happening during it, to alter the relative position of landlord and tenant, are viewed in very different lights by the two classes of landlords, and always to the prejudice of the tenant, by the inexperienced class. There are farmers whose capital and force of character enable them to pursue an independent and successful course of farming, in spite of every obstacle that would effectually impede the career of others; but such characters, though good farmers, and therefore valuable tenants on any estate, are few in number; and when seen to make a little money, seldom fail to excite the jealousy of landlords unacquainted with farming, who, to account for their success, imagine that the land has been made to do more than it should. On the other hand, such tenants are just the men whom landlords acquainted with farming would desire to occupy *their* farms.

It is undeniable, that every advantage which tenants on estates belonging to landlords unacquainted with farming do possess, may also be possessed by those under practical landlords, besides many minor circumstances which the former class of landlords cannot appreciate as being at all conducive to the welfare and comfort of tenants.

These maxims of Bacon seem not an inapt conclusion to our present remarks: "He that cannot look into his own estate at all, had need both choose well those whom he employeth, and change them often, for new are more timorous and less subtle. He that can look into his estate but seldom, it behoveth him to turn all to certainties." *

8. OF EXPERIMENTAL FARMS AS PLACES FOR INSTRUCTION IN FARMING.

> "Things done without example, in their issue
> Are to be feared."
>
> HENRY VIII.

It seems to be a favourite notion with some writers on agricultural subjects, that, of all places for learning farming, experimental farms are the best. They even recommend the formation of experimental farms, with the view of affording to young men the best system of agricultural education. They go the length of confidently asserting that all the field operations and experiments, on experimental farms, could be conducted by pupils. And they are nearly unanimous in conceiving that 200 acres would be a large enough extent for an experimental farm, and that on such a farm 100 pupils could be trained to become farmers, stewards, and ploughmen.

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* Essays, p. 106.

A very slight consideration of the nature of an experimental farm, will serve to shew how unsuitable such a place is for *learning* farming. The sole object of an experimental farm is, to become acquainted with the best properties of plants and animals by experiment, and thereby to ascertain whether those properties are such as would recommend them for introduction to an ordinary farm. It is obvious, from this statement, that it is needless following, on an experimental farm, the *usual modes* of cultivating the ordinary plants and of rearing the ordinary animals of a farm. Either *new* plants, and *other* modes than the usual ones of cultivating and rearing the ordinary plants and animals, should be tried on an experimental farm, otherwise it would not be an *experimental* farm, or of more use than an ordinary farm. In witnessing new or unusual modes of culture, the pupil would thus learn nothing of the particulars of *ordinary farming*. Extraordinary modes of cultivating ordinary plants, by changes in the rotation or of manure, and the risk of failure in both—for failure is a necessary condition of experiment—would only serve to impress the minds of *pupils* with experimental schemes, instead of guiding them to the most approved plan of cultivating each sort of plant. To confound the mind of a beginner, by presenting before it various modes of doing the same thing, without the ability to inform it which is the best, is to do him a lasting injury. Were a pupil, who had been trained up on an ordinary farm, to have opportunities of witnessing varieties of experiments conducted on an experimental farm, he might then derive benefit from numerous hints which would be suggested in the course of making the experiments. But if pupils would be unfavourably placed on an experimental farm, by remaining constantly on it, much more would the farm itself be injured, by having its experiments performed by inexperienced pupils. So far from *pupils* being able to conduct experiments to a satisfactory issue, the most experienced cultivators are at times baffled by unforeseen difficulties; and so far would *such* experiments inspire confidence in farmers, that they would assuredly have quite an opposite tendency. So far, therefore, would the services of pupils in any degree compensate for the extraordinary outlay occasioned on experimental farms, by unsuccessful or unprofitable experiments, that even those of the most experienced cultivators would most probably produce no such desirable result; for no *experimenter* can command success, and failure necessarily implies extraordinary outlay. So far, therefore, could the services of pupils accomplish what those of experienced cultivators could not command, that their very presence on an *experimental* farm, with the right of co-operating in the experiments, would be a constant source of inconvenience to the experienced experimenters.

But, besides these objections, the mode of conducting experiments on so small farms as those recommended by most writers, would be quite unsuitable to pupils desirous of *learning* farming. Where varieties of culture on various sorts of plants are prosecuted on a small extent of ground, only a very small space can be allotted to each experiment. It is true, that, should any of the varieties of plants be new to this country, the seed of which at first being of course only obtainable in small quantities, to procure such being a primary object with the promoters of experimental farms, the space required for them at first must be very small. But although each lot of ground should be small, the great varieties of seeds cultivated in so many different ways, will nevertheless require a great number of lots, which altogether will cover a considerable extent of ground. How all these lots are to be apportioned on 200 acres, together with ground for experimenting on different breeds of animals, and different kinds of forest trees, is more than I can imagine. It would require more than double that extent of ground to give mere standing-room to all the objects that should be cultivated on an experimental farm, and over and above which, 100 pupils on such a farm would form a perfect crowd. Besides, the lots being so small, would require to be worked with the spade instead of the plough; and this being the case, let the experiments on such a farm be ever so perfectly performed, they could give pupils no insight whatever into real *farming*, much less secure the confidence of *farmers.*

It is the pleasure of some writers on experimental farms, to institute a comparison, or even strict analogy, betwixt them and experimental gardens. As the latter have improved the art of gardening, they argue, so would the former improve agriculture. But the truth is, there can be no analogy betwixt the introduction into common gardens, of the results obtained in experimental gardens, and the results of experiments obtained in such small experimental farms as recommended by agricultural writers, introduced into the common field culture of a farm; because, the experiments in an experimental garden having been made by the spade, may be exactly transferred into almost any common garden, and, of course, succeed there satisfactorily; whereas the experiments made by the spade in a small experimental farm, cannot be performed with the spade on a common farm; they must there be executed by the plough, and, of course, in quite different circumstances. The rough culture of the plough, and most probably in different circumstances of soil, manure, and shelter, cannot possibly produce results similar to the culture of the spade, at least no farmer will believe it; and if *they* put no confidence in experiments, of what avail will experimental farms be? Announcements of such results may gratify curiosity, but no benefit would be conferred on the country by experiments confined within the inclosures of an experimental farm. No doubt, a few of the most unprejudiced of the farmers will perform any experiment, with every desire for its success, and there is as little doubt that others will follow the example; and some will be willing to test the worth of even a suggestion; but as these are the usual modes by which every new practice recommends itself to the good graces of farmers, no intervention of an experimental farm is therefore required for their promulgation and adoption. It is the duty of the promoters of experimental farms, to disseminate a proved experiment quickly over the country, and the most efficient mode of doing so is to secure the confidence of farmers in it. To insure *their* confidence, it will be necessary to shew them, that they can do the same things as have been done on the experimental farm *by the usual means of labour* they possess, and they will then shew no reluctance to follow the example. Take the risk, in the experimental farm, of proving results, and shew the intrinsic value of those results to the farmers, and the experiments, of whatever nature, will be performed on half the farms of the kingdom in the course of the first season.

For this purpose it is necessary to ascertain the size an experimental farm should be, which will admit of experiments being made on it, in a manner similar to the operations of a farm. The leading operation, which determines the smallest size of the fields of an experimental farm, is ploughing. The fields should be of that size which will admit of being ploughed in ordinary time. and at the same time not larger than just to do justice to the experiments performed in them. I should say that *five* acres imperial is the least extent of ground to do justice to ploughing ridges along, across, and diagonally. *Three* acres, to be of such a shape as not to waste time in the ploughing, would have too few ridges for a series of experiments, and to increase their number would be to shorten their length, and lose time in ploughing. But even five acres are too small to inclose with a fence; ten acres, a good size of field for small farms, being nearer the mark for fencing. Taking the size of an experimental plot at five acres, the inclosure might be made to surround the divisions of a rotation; that is, of a rotation of four years, let twenty acres be inclosed; of five years, twenty-five acres, &c.; but in this arrangement the experiments would only prove really available to small tenants, who frequently cultivate all their crops within one fence, and the subject thus experimented on would not be individually inclosed within a fence, as is the case with crops on larger farms.

The whole quantity of land required for an adequate experimental farm may thus be estimated. New varieties of seeds would require to be increased by all the possible modes of reproduction. Old varieties should undergo impregnation,—be subjected to different modes of culture,—be preserved pure from self-impregnation,—and be grown in different altitudes. Each variety of seed already cultivated, such as wheat, barley, oats, potatoes, turnips, &c., to undergo these various modifications of treatment on five acres of land, would, including the whole, require an immense extent of ground, and yet, if each kind did not undergo all these varieties of treatment, who could then aver that all our seeds had been subjected to satisfactory *field* experiments? Only *one* kind of grain, treated as variedly as might be, on five acres for each modification of treatment, would occupy *seventy* acres; and were only five kinds of seed taken, and only five varieties of each, and the whole cultivated on both low and high ground, the quantity of ground required altogether would be 3500 acres. The extent of ground thus increases in a geometrical progression, with an increase of variety of plants. Besides, the numerous useful grasses, for the purposes of being cut green, and for making into hay, would require other 1000 acres. The whole system of pasturing young and old stock on natural and artificial grasses in low grounds and on high altitudes, and in sheltered and exposed situations, would require at least 3000 acres. Then, experiments with forest-trees, in reference to timber and shelter in different elevations and aspects, would surely require 1000 acres. Improvements in bog and muir lands should have other 1000 acres. So that 9500 acres would be required to put only a given proportion of the objects of cultivation in this country to the test of full experiment. Such an extent of ground will, no doubt, astonish those who are in the habit of talking about 200 acres as capable of affording sufficient scope for an experimental farm. Those people should be made to understand that the plough must have room to work, and that there is no other way of experimentizing satisfactorily for *field* culture, on an experimental farm, but by affording it a real field to work in. If less ground be given, fewer subjects must be taken; and if any subject is rejected from experiment, then the system of experimentizing will be rendered incomplete. The system of experimentizing should be carried out to the fullest extent of its capability on experimental farms, or it should be left, as it has hitherto been, in the hands of farmers. The farmers of Scotland have worked out for themselves an admirable system of husbandry, and if it is to be improved to a still higher pitch of skill by experimental farms, the means of improvement should be made commensurate with the object, otherwise there will be no satisfaction, and certain failure; for the promoters of experimental farms should keep in mind, that the existing husbandry, improved as it is, is neither in a stationary nor in a retrograding, but in a progressive state towards farther improvement. Unless, therefore, the proposed experiments, by which it is intended to push its improvement still farther towards perfection, embrace every individual of the multifarious objects which engage the attention of agriculturists, that one may be neglected, which, if cultivated, would have conferred the greatest boon on agriculture. I come, therefore, to this conclusion in the matter: that *minute* experiments on the progressive developments of plants and animals are absolutely requisite to establish their excellence or worthlessness, and these can be performed on a small space of ground; but to stop short at this stage, and not pursue their culture on a *scale commensurate with the operations of the farm*, is to render the experimental farm of little avail to practical husbandry, and none at all to interest the farmer.

So large an extent of farm would most probably embrace all the varieties of soil. It should, moreover, contain high and low land, arable, bog, and muir land, sheltered and exposed situations, and the whole should lie contiguous, in order to be influenced by the climate of the same locality. It would scarcely be possible to procure such an extent of land under the same landlord, but it might be found in the same locality on different estates. *Such* a farm, rendered highly fertile by draining, manuring, liming, and labour, and plenished, as an experimental farm should be, with *all* the varieties of crop, stock, implements, and woods, would be a magnificent spectacle worthy of a nation's effort to put into a perfect state for a national object. What a wide field of observation would it present to the botanical physiologist, containing a multiplicity of objects made subservient to experiment! What a laboratory of research for the chemist, amongst every possible variety of earths, manures, plants, and products of vegetation! What a museum of objects for the naturalist, in which to observe the living habits and instincts of animals, some useful to man, and others injurious to the fruits of his labour! What an arena upon which the husbandman to exercise his practical skill, in varying the modes of culture of crops and live-stock! What an object of intense curiosity and unsatisfying wonder to the rustic labourer! But above all, what interest and solicitude should the statesman feel the appliance of such a mighty engine, set in motion, to work out the problem of agricultural skill, prosperity, and power.*

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* Paper by me on the subject in the Quart. Jour. of Agri., vol. vii. p. 538.

9. A FEW WORDS TO YOUNG FARMERS WHO INTEND EMIGRATING AS AGRICULTURAL SETTLERS TO THE COLONIES.

> " Such wind as scatters young men through the world, to seek their fortunes farther than at home."
>
> TAMING OF THE SHREW.

For some years past the tide of emigration has set very strongly towards the shores of our colonial possessions. To attempt to ascertain the causes of this emigration, or to speculate on the probability of its success, would be quite irrelevant in this place; suffice it to be cognizant of the fact, that many people, of late years, have gone from Great Britain to settle for ever in America and Australia. Whatever may have been their former pursuits, almost the whole have emigrated with the view of becoming agricultural settlers,—either to become owners of land, or continue to be what they were in this country, agricultural labourers.

In all new countries, the price of labour for a time is high, and in consequence skilful labourers, in every department of industry, as long as they choose to engage in employment, cannot fail to earn money; for although certain sorts of provisions, that require much preparatory labour to produce them, may be dear in a new country, yet others, being more easily raised on account of their suitableness to the climate, are not exorbitant in price; and, at all events, the prices of both range comparatively lower in the circumstances than the rate of wages. Labourers, prompted by premature ambition to become owners of land,—" who hasten to be *rich*,"—entail insurmountable misery on themselves and families. Expending the little capital they had earned as servants in purchasing land, they possess no means to employ the dear labour of others; and ere the fruits of their own industry can afford them sufficient sustenance, they suffer real privations, or are obliged to obtain assistance from others on very disadvantageous terms. But however imprudently they may act in regard to their finances, and short-sightedly with respect to their future welfare, the labouring class, in all circumstances, possess the advantage of being brought up to a profession, and thus, though agricultural labourers may not have the means of employing others, they know well how to labour the land for their *own advantage*.

The same eulogium, I fear, cannot be pronounced on most of the emigrants who leave this country with the professed determination of becoming *owners* of land. Many have had no opportunities at all of becoming acquainted with agriculture; whilst others who profess to know it, know so little of it that their knowledge avails them very little when they engage in active husbandry on their settlements. Notwithstanding these exceptions, no doubt there are many emigrants who understand farming quite well. Now, I think, emigrants intending to pursue agriculture in the new country, injure their own interests very materially, by adopting the irrational plan of neglecting to learn the business they are about to engage in. They should all, without exception, know farming before they leave this country. I say without exception, for though some may, perhaps, be pretty far advanced in life, before they determine on emigrating, and though grown up persons dislike to encounter the supposed shame of learning a new trade, whilst others grudge the time and money that would cost them to learn it,—imagining that the money would be better laid out in their new speculation,—yet worse-founded opinions could not be entertained; for although advanced in life, and thereby enfeebled before leaving the land of their nativity, their new profession would be far more pleasantly acquired amidst the comforts of home, than the unavoidable inconveniences of a first settlement in a foreign land; and no man, of whatever age, should display the folly of being above learning the business he intends to pursue in future. Emigrants may be assured that they will be obliged to learn farming abroad, for it cannot come to them intuitively, and then they will discover it, when too late, to be much easier for them to exercise an acquired skill to bring in land from a state of nature to tillage, than to acquire that skill at the risk of starving their infant colony, by most probably misdirecting their efforts,—the injurious effects of which they may feel for many years to come. This is what they would term learning farming by experience, but it is very dear-bought experience, far more expensively acquired than by a little money judiciously laid out at home in learning it on another's farm. If they had learned it so, not only money, but much misdirected labour, which is equivalent to money, as well as much uneasiness of mind, would have been saved them. If emigrants possessing land are entirely ignorant of farming, they must chiefly trust to the skill and honesty of their servants, who, receiving high wages and board, and thereby being more independent in circumstances than their masters, soon become indispensable persons in their peculiar situation; and, who, imagining themselves beyond the power of the law and the chances of detection, are strongly tempted to aggrandize themselves rather than attend to the interest of their masters. Thus circumstanced, a handful of corn can be easily concealed, a drop of milk purloined every day from the cows, and a pig, or a sheep, or even a bullock, can be stolen or gone astray, when it suits their purpose.

But *young* men have no valid excuse for neglecting to learn farming before they set out to take possession of the "promised land." The plea of having plenty of time to learn farming in the colony ere old age overtake them, or plenty of cash to purchase experience of colonial agriculture, is an excuse only befitting the thoughtless and procrastinating; nor should the somewhat correct assumption, that the agriculture of the old country is not exactly applicable to the colonies, serve them as a better; for however modified field operations may be executed in different countries, the nature of land, of vegetables, and of animals, is the same in every country; and if the nature of these particulars are well understood here, there is little doubt but the knowledge may be applied with advantage in the colonies. These, however, are only plausible excuses; for though colonial farming may be learnt from old and experienced settlers,—and the plan is far better than commencing in ignorance operations on one's own account and in entire dependence on servants;—yet, it should be borne in mind, that few young emigrants will have the patience to remain so long with settlers as to acquire a competent knowledge of farming, when they perceive that they themselves might be enjoying the advantages they behold; besides, such a procedure would render abortive the determination of those emigrants who wish to take out farm-servants and implements of husbandry,—a plan which they must relinquish if they have to learn their profession in the colonies. But, I believe, there is little foundation for the assertion that colonial agriculture differs from our own. Wherever the *same kinds of crops* are raised, the *same principles* of culture must be adopted; and wherever the *same sorts of stock* are reared for the *same purposes*, the *same system* must be pursued in their management. Superior fertility of soil, amenity of climate, or nourishment in the food of animals, but slightly affect the application of principles, and only modify the application of practice. Want of efficient beasts of labour and implements may at first induce settlers to try extraordinary expedients to accomplish the desired end, but as those means improve, and the ground is by them brought into tillage, the peculiarities of colonial agriculture will gradually yield to the more matured and elastic practice of the old country. Eventually, the colonies will, I conceive, exhibit splendid examples of British agriculture, under the cherishing auspices of a fine climate. The sooner it attains that perfection, the more quickly will the prosperity of the settlers be secured; and nothing will delay its consummation so effectually as emigrants designing to engage in agriculture quitting this country in breathless haste, in total ignorance of husbandry.

Let *every* intending settler, therefore, *learn agriculture thoroughly* before he emigrates; and, if it suits his taste, and time, and arrangements, let him then study in the colony the necessarily imperfect system of agriculture usually pursued by the settlers before he embarks in it on his own account; and the full knowledge acquired here, will enable him not only to comprehend the whole system there in a very short time, but to select the part of the country best suited to his purpose, and to avoid what is erroneous. A knowledge of his profession prior to emigration, will enable him the more easily to estimate those particulars in a proper point of view. But in truth he has a much higher motive for learning agriculture here, as a thorough acquaintance of it will enable him, at once, to make the best use there of the inadequate means of culture which every emigrant must at first experience, by knowing how to apply animal labour in the culture of the new soil, when at all practicable, instead of manual, as long as wages are high,—how to suit the kind of crop to the nature and present state of the soil;—how to use expedients to gain the end in view, by accommodating labour to the existing state of the weather, the nature and condition of the crop or soil, or the state of the implements;—how to exercise ingenuity in the construction of dwellings to secure the comfort of himself and family, and accommodation of live-stock and provisions, which can best be acquired by a familiar acquaintance with farm buildings;—how to exercise a general superintendence over every department of work, so as to shew an intimate acquaintance with them, and which acquirement never fails to maintain a proper authority over every person in his employment. These are advantages which every emigrant can purchase here, but not in the colonies; but which can only be acquired by studying agriculture in one of the best districts of this country. They are advantages equivalent to capital to emigrants. No study, however lengthened, of the present state of colonial agriculture,—which may be said to have been worked out by dint of trial and failure,—will ever tutor the settler's mind so accurately as to enable him to turn every change of circumstances to the best advantage. This faculty can only be acquired at home, or with settlers in the colony, who have been experienced farmers at home; and which, acting like an additional sense, gives an insight into the management of land and stock, which those who do not possess it can have no conception. This statement may be derided by those agricultural settlers who have emigrated to the colonies, and succeeded in amassing fortunes without any knowledge of agriculture but what they had picked up by degrees on the spot, but such persons are incompetent to judge of the nature of the statement, never having been influenced by its principle; and how favourable soever the issue of their own exertions may have proved, there is no question they would have realized much larger fortunes in the time, or the same amount in a shorter time, had they brought a thorough acquaintance of the most perfect system of husbandry known to operate on the favourable circumstances which they occupied; not that a *perfect* system could at once be practised in a new colony, but its knowledge would have enabled them sooner to have brought their land into a superior state of cultivation, and their live-stock into a superior condition to yield larger profits. Deny this averment who may, will find great difficulty in disproving it.

10. OF THE KIND OF EDUCATION BEST SUITED TO YOUNG FARMERS.

> "Between the physical sciences and the arts of life there subsists a constant mutual interchange of good offices, and no considerable progress can be made in the one, without of necessity giving rise to corresponding steps in the other. On the one hand, every art is in some measure, and many entirely, dependent on those very powers and qualities of the material world which it is the object of physical inquiry to investigate and explain."
>
> HERSCHEL.

With respect to the education of young farmers, no course of elementary education is better than what is taught at the excellent parochial schools of this country. The sons of farmers and of peasants have in them a favourable opportunity of acquiring the elements of a sound education, and they happily avail themselves of the opportunity; but, besides elementary education, a classical one sufficiently extensive and profound for farmers, may there also be obtained. But there are subjects of a different nature, sciences suited to the study of maturer years, which young farmers should make a point of learning,—I mean the sciences of Natural Philosophy, Natural History, Mathematics, and Chemistry. These are taught at colleges and academies. No doubt these sciences are included in the curriculum of education provided for the sons of landowners and wealthy farmers; but every class of farmers should be taught them, not with a view of transforming them into philosophers, but of communicating to them the important knowledge of the nature of those phenomena which daily present themselves to their observation. Such information would make them more intelligent farmers, as well as men. The advantages which farmers would derive from studying those sciences, will be best understood by pointing out their nature.

It is evident that most farming operations are much affected by external influences. The state of the weather, for instance, regulates every field operation, and local influences modify the climate very materially. Now it should be desired by the farmer to become acquainted with the causes which give rise to those influences, and these can only be known by comprehending the laws of nature which govern every natural phenomenon. The science which investigates the laws of these phenomena, is called *Natural Philosophy*, and it is divided into as many branches as there are classes of phenomena. The various classes of phenomena occur in the earth, air, water, and heavens. The laws which regulate them being unerring in their operation, admit of absolute demonstration; and the science which affords the demonstration is called *Mathematics*. Again, every object, animate or inanimate, that is patent to the senses, possesses an individual identity, so that no two objects can be confounded together. The science which makes us acquainted with the marks for identifying individuals, is termed *Natural History*. Farther, every object, animate or inanimate, cognizable by the senses, is a compound body made up of certain elements. *Chemistry* is the science which makes us acquainted with the nature and combinations of those elements. We thus see how generally applicable those sciences are to the phenomena around us, and their utility to the farmer will be the more apparent, the more minutely each of them is investigated. Let us take a cursory view of each subdivision as it affects agriculture.

Mathematics are either abstract or demonstrative. Abtract mathematics "treat of propositions which are immutable, absolute truth," not liable to be affected by subsequent discoveries, "but remains the unchangeable property of the mind in all its acquirements." Demonstrative mathematics are also strict, but are "interwoven with physical considerations;" that is, subjects that exist independently of the mind's conceptions of them or of the human will; or, in other words still, considerations in accordance with nature. Mathematics thus constitute the essential means of demonstrating the strictness of those laws which govern natural phenomena. Mathematics must, therefore, be first studied before those laws can be understood. Their study tends to expand the mind,—to enlarge its capacity for general principles,—and to improve its reasoning powers.

Of the branches into which Natural Philosophy is divided, that which is most useful to farmers is *Mechanics*, which is defined to be " the science of the laws of matter and motion, so far as is necessary to the construction of machines, which, acting under those laws, answer some purpose in the business of life." Without mechanics, as thus defined, farmers may learn to *work* any machine which answers their purpose ; but it is only by that science they can possibly understand the *principles* upon which any machine is constructed, nor can any machine be properly constructed in defiance of those principles. Both machinists and farmers ought to be versed in mechanical science, or the one cannot make, and the other guide, any machine as it ought to be ; but, as I have had occasion to express my sentiments on this subject already, I shall abstain from dilating further upon it here. Mathematical demonstration is strictly applicable to mechanics, whether as to the principles on which every machine operates, or the form of which it is constructed. The *principles* of mechanics are treated of separately under the name of *Dynamics*, which is defined to be " the science of force and motion."

Pneumatics is the branch of natural philosophy which is next to mechanics in being the most useful to the farmer to know. It " treats of air, and the laws according to which it is condensed, rarefied, gravitates." The states of the air, giving a variable aspect to the seasons, as they pursue their " appointed course," endue all atmospherical phenomena with extreme interest to the farmer. Observation alone can render variety of phenomena familiar ; and their apparent capriciousness, arising most probably from the reciprocal action of various combinations of numerous elements, renders their complicated results at all times difficult of solution ; for all fluids are susceptible of considerable mutations, even from causes possessing little force ; but the mutations of elastic fluids are probably effected by many inappreciable causes. Nevertheless, we may be assured, that no change in the phenomena of the atmosphere, however trivial, takes place but as the unerring result of a definite law, be it chemical or physical.

Closely connected with pneumatics, in so far as the air is concerned, are the kindred natural sciences of *Electricity* and *Magnetism*. These agencies, though perfectly perceptible to one or more of the senses, and evidently constantly at work in most of the phenomena of the atmosphere, are mysteriously subtle in their operations. It is extremely probable, that one or both are the immediate causes of all the changes which the atmosphere is continually undergoing. It is hardly possible that the atmosphere, surrounding the globe like a thin envelop, and regularly carried round with it in its diurnal and annual revolutions, should exhibit so very dissimilar phenomena every year, but from some disturbing cause, such as the subtile influences of electricity, which evidently bear so large a share in all remarkable atmospherical phenomena. Its agency is the most probable cause of the *irregular* currents of the air called winds, the changes of which are well known to all farmers to possess the greatest influence on the weather.

Natural History comprehends several branches of study. *Meteorology* consists of the observation of the apparent phenomena of the atmosphere. The seasons constitute a principal portion of these phenomena. The clouds constitute another, and are classified according to the forms they assume, which are definite, and indicative of certain changes. The winds constitute a third, and afford subject for assiduous observation and much consideration. Attention to the directions of the wind and forms of the clouds will enable farmers to anticipate the kind of weather that will afterwards ensue in a given time in their respective localities. The prevalence of the aqueous meteors of rain, snow, hail, and ice, is indicated by the state of the clouds and winds.

Hydrography is the science of the watery part of the terraqueous globe. It makes us acquainted with the origin and nature of springs and marshes, the effects of lakes, marshes, and rivers, on the air and on vegetation in their vicinity; and the effects of sea air on the vegetation of maritime districts.

Geology is the knowledge of the substances which compose the crust of the earth. It explains the nature and origin of soils and subsoils; that is, the manner in which they have most probably been formed, and the rocks from which they have originated: It discovers the relative position, structure, and direction in which the different rocks usually lie. It has as yet done little for agriculture; but a perfect knowledge of geology might supply useful hints for draining land, and planting trees on soils and over subsoils best suited to their natural habits, a branch of rural economy as yet little understood, and very injudiciously practised.

Botany and *botanical physiology*, which treat of the appearance and structure of plants, are so obviously useful to the agricultural pupil, that it is unnecessary to dilate on the advantages to be derived from a knowledge of both.

Zoology, which treats of the classification and habits of all animals, from the lowest to the highest organized structure, cannot fail to be a source of constant interest to every farmer who rears stock. There are few wild quadrupeds in this country; but the insect creation itself would employ a lifetime to investigate.

Anatomy, especially *comparative anatomy*, is highly useful to the farmer, inasmuch as it explains the functions of the internal structure of animals upon which he bestows so much care in rearing. Acquainted with the functions of the several parts which constitute the corporeal body, he will be the better able to apportion the food to the peculiar constitution of the animal; and also to anticipate any tendency towards disease, by a previously acquired knowledge of premonitory symptoms. Comparative anatomy is most successfully taught in veterinary schools.

The only other science which bears directly on agriculture, and with which the pupil farmer should make himself acquainted, is *Chemistry;* that science which is cognizant of all the changes in the constitution of matter, whether effected by heat, by moisture, or other means. There is no substance existing in nature, but is susceptible of chemical examination. A science so universally applicable, cannot fail to arrest popular attention. Its popular character, however, has raised expectations of its power to assist agriculture, to a much greater degree, than the results of its investigations yet warrant. It is very generally believed, not by practical farmers, but chiefly by amateur agriculturists, who profess great regard for the welfare of agriculture, that the knowledge derived from the analysis of soils, manures, and vegetable products, would develop general principles, which might lead to the establishment of a system of agriculture, as certain in its effects as the unerring results of science. Agriculture, in that case, would rank among the experimental *sciences*, the application of the principles of which would necessarily result in increased produce. The positive effects of the weather seem to be entirely overlooked by these amateurs. Such sentiments and anticipations are very prevalent in the present day, when every sort of what is termed *scientific* knowledge are sought after with an eagerness as if prompted by the fear of endangered existence. This feverish anxiety for scientific knowledge is very unlike the dispassionate state of mind induced by the patient investigation of true science, and very unfavourable to the right application of the principles of science to any practical art. Most of the leading agricultural societies instituted for the promotion of practical agriculture, have been of late assailed by the entreaties of enthusiastic amateur agriculturists, to construct their premiums to encourage only that system of agriculture which takes chemistry for its basis.

These are the physical sciences whose principles seem most applicable to agriculture; and being so, they should be studied by every farmer who wishes to be considered an enlightened member of his profession. That farmers are quite competent to attain to these sciences, may be gathered from these observations of Sir John Herschel:—" There is scarcely any well-informed person, who, if he has but the will, has not the power to add something essential to the general stock of knowledge, if he will only observe regularly and methodically some particular class of facts which may most excite his attention, or which his situation may best enable him to study with effect. To instance one subject which *can* only be effectually improved by the united observations of great numbers widely dispersed:—Meteorology, one of the most complicated but important branches of science, is at the same time one in which any person who will attend to plain rules, and bestow the necessary degree of attention, may do effectual service." But in drawing our conclusions, great caution is requisite, for, " In forming inductions, it will most commonly happen that we are led to our conclusions by the especial force of some two or three strongly impressive facts, rather than by affording the whole mass of cases a regular consideration; and hence the need of cautious verification. Indeed, so strong is this propensity of the human mind, that there is hardly a more common thing than to find persons ready to assign a cause for every thing they see, and in so doing, to join things the most incongruous, by analogies the most fanciful. This being the case, it is evidently of great importance that these first ready impulses of the mind should be made on the contemplation of the cases most likely to lead to good inductions. The misfortune, however, is, in natural philosophy, that the choice does not rest with us. We must take the instances as nature presents them. Even if we are furnished with a list of them in tabular order, we must understand and compare them with each other, before we can tell which *are* the instances thus deservedly entitled to the highest consideration. And, after all, after much labour in vain, and groping in the dark, accident or casual observation will present a case which strikes us at once with a full insight into the subject, before we can even have time to determine to what class its *prerogative* belongs."*

Many farmers, I dare say, will assert it to be far beyond the reach of their means, and others beyond their station, to bestow on *their* sons so learned an education as that implied in the acquirement of the sciences just now enumerated. Such apprehensions are ill-founded; because no farmer that can afford to support his sons at home, without working for their bare subsistence, but possesses the means of giving them a good education, as I shall immediately prove; and no farmer, who confessedly has wealth, should grudge his sons an education that will fit them to adorn the profession they intend to follow.

It cannot be denied, that a knowledge of mathematics and natural philosophy greatly elevates the mind. Those farmers who have acquired these sciences, must be sensible of their tendency to do this; and they will therefore naturally wish *their* sons to enjoy what they themselves do. Those who of themselves do not know these sciences, on being informed of their beneficial tendency, will probably feel it to be their duty to educate their sons, and thereby put it in their power to raise themselves in society and at the same time shed a lustre on the profession of which they are members. The same species of reasoning applies to the acquirement of the peculiar accomplishments bestowed on the mind by a knowledge of natural history and chemistry. Neither the time nor expense of acquiring such an education is of that extent or magnitude, as to deter any farmer's son from attempting it, who occupies a station above that of a farm steward. Besides these considerations, a good education, as the trite saying has it, is the best legacy a parent can leave his child; and, on this account, it is better for the young farmer himself to bestow on him a superior education, in the first instance, with a part even of the money destined by his father to stock him a farm, than to plenish for him a larger farm, and stint his education. The larger farm would, no doubt, enable the half-educated son to earn a livelihood more easily; but the well-educated one would be more than compensated in the smaller farm, by the possession of that cultivated intelligence, which would induce him to apply the resources of his mind to drawing forth the capabilities of the soil, and making himself an infinitely superior member of society. Were industrious farmers as eager to improve their sons' minds by superior education, as they too often are to amass fortunes for them,—a boon unprofitably used by uncultivated minds,—they would display more wisdom in their choice. No really sensible farmer should hesitate to decide which course to take, when the intellectual improvement of his family is concerned. He should never permit considerations of mere pelf to overcome a sense of right and of duty. Rather than prevent his son having the power to raise himself in his profession, he should scrupulously economize his own expenditure.

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* Discourse on the Study of Natural Philosophy, pp. 133, 182.

I shall now shew that the time occupied in the acquisition of those sciences which are expedient for the farmer to learn, is not lost when compared with the advantages which they may bestow. *Part of three years* will accomplish all, but three years are doubtless an immense time for a young man to *lose!* So it would be; but, to place the subject in its proper light, I would put this statement and question for consideration, Whether the young farmer's *time*, who is for years constantly following his father's footsteps over the farm, and only superintending a little in his absence, while the father himself is, all the time, quite capable of conducting the farm, is not as much *lost*, as the phrase has it, as it would be when he is occupied in acquiring a scientific education at a little distance from home? Insomuch as the young man's *time* is of use to the *farm*, the two cases are nearly on a par; but, in as far as both cases affect himself, there is no question that science would benefit him the more,—no question that a superior education would afterwards enable him to learn the practical part of his profession with his father, with much greater ease to himself. The question is thus narrowed to the consideration of the alternative of the cost of keeping the son at home, following his father as idly as his shadow, or of sending him to college. Even in this pecuniary point of view, the alternative consists merely of the difference of maintenance at home, and that in a town, with the addition of fees. That this difference is not great, I shall now shew.

Part of three years, as I have said, would accomplish all amply, and in this way;—the first year to be devoted to mathematics, the second to natural philosophy, and the third to natural history and chemistry; and along with these principal subjects, some time in both years should be devoted to geography, English grammar and composition, book-keeping, and a knowledge of cash transactions. The two months vacation in each year could be spent at home. There are seminaries at which these subjects may be studied, at no great distance from every farmer's home. There are, fortunately for the youths of Scotland, universities, colleges, and academies, in many parts of the country. Edinburgh, Glasgow, Aberdeen, and St Andrews, can boast of well-endowed universities and colleges; whilst the academies at Dundee, Perth, Ayr, Dollar, and Inverness, have been long famed for good tuition.

For the study of mathematics and natural philosophy, I would prefer the academies to the colleges, because their session occupies ten months, and two hours each day are devoted to each subject; whereas the college session is at most six months, and only one hour each day is appropriated to one subject. At the academies, other two hours are daily occupied with geography and English composition. The longer session, and the fuller teaching on each subject, at the same fee, are great advantages to students; and it will be found that the more fully mathematics and natural philosophy are treated, the greater fascinations they present to the student. Two sessions of twenty months might thus be profitably employed at the academy in learning mathematics, natural philosophy, geography, English grammar, and the theory of book-keeping.

Natural history and chemistry are best acquired at college, as they are not always taught, and never fully so, at the academies; and without the most ample experiments and illustrations, which cannot be expected to be afforded in provincial towns,—the seats of the academies,—these sciences cannot be profitably studied.

The cost of acquiring all those subjects at the several colleges and academies is not insurmountable, even to the limited purse of a small farmer. In any of the towns mentioned as possessing an academy, the *two* sessions of twenty months would not exceed in board at the large allowance, in a provincial town, of a guinea a-week, and fees twelve guineas, L.105; and the short session of six months at college, at a guinea a-week, and eight guineas for fees, other L.35, making in all, in twenty-six months, L.140. This is a small sum compared with the advantages to be derived from it by the young farmer, and *from it falls to be deducted the cost of keeping him at home in idleness*, which, even at ploughmen's usual wages of 10s. a-week, would amount in that time to L.56, so that his education would only cost L.84; but economy, practised by frugal habits, might make a smaller sum suffice; and, on the other hand, a larger might not be grudged to make a diligent student comfortable, by those who have no cause to economize.

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11. OF THE DIFFERENT KINDS OF FARMING.

> "I'll teach you differences."
>
> LEAR.

Perhaps the young farmer will be astonished to learn that there are many and various systems of farming; yet so in reality is the case, and moreover, that they all possess very distinctive characteristics. There are *six* kinds of farming practised in Scotland alone; and though all are pursued under some circumstances common to all, and each kind is perhaps best adapted to the particular soil and situation in which it is practised; yet it is highly probable that one of the kinds might be applicable to, and profitably followed, in all places of nearly similar soil and locality. Locality, however, determines the kind of farming fully more than the soil; the soil only entirely determining it when of a very peculiar consistence. The comparative influence of locality over soil in determining this point will be better understood after shortly considering each kind of farming.

1. One kind is wholly confined to *pastoral* districts, which are chiefly situated in the Highlands and Western Isles of Scotland,—in the Cheviot and Cumberland hills of England,—and very generally in Wales.

In all these districts, farming is almost restricted to the breeding of cattle and sheep; and, as natural pasture forms the principal food of live-stock in a pastoral country, very little arable culture is there practised for their behoof. Cattle and sheep are not always both reared on the same farm. Cattle are reared in very large numbers in the Western Isles, and in the *pastoral valleys* among the mountain-ranges of England, Wales, and Scotland. Sheep are reared in still greater numbers in the *upper parts* of the mountain-ranges of Wales and of the Highlands of Scotland; and on the green round-backed mountains of the south of Scotland and the north of England. The cattle reared in pastoral districts are small sized, chiefly black coloured, and horned. Those in the Western Isles, called "West Highlanders," or "Kyloes," are esteemed a beautifully symmetrical and valuable breed of cattle. Those in the valleys of the Highland mountains, called "North Highlanders," are considerably inferior to them in quality, and smaller in size. The black-faced, mountain, or heath, horned sheep, are bred and reared on the upper mountain-ranges, and fattened in the low country. The round-backed green hills of the south are mostly stocked with the white-faced, hornless, Cheviot breed; though the best kind of the black-faced breed is also reared in some localities of that district, but seldom both breeds are bred by the same farmer. Wool is a staple product of sheep pastoral farming.

Pastoral farms are chiefly appropriated to the rearing of one kind of sheep, or one kind of cattle; though both classes of stock are bred where valleys and mountain-tops are found on the same farm. The arable culture practised on them is confined to the raising of provisions for the support of the shepherds and cattle-herds; and perhaps of a few turnips, for the support of the stock during the severity of a snow-storm; but the principal artificial food of the stock in winter is hay, which in some cases is obtained by inclosing and mowing a piece of natural grass on a spot of good land, near the banks of a rivulet, the alluvial soil along the river sides being generally of fine quality. All pastoral farms are large, some containing many thousands of acres,—nay miles in extent; but from 1500 to 3000 acres is perhaps an ordinary size.* Locality determines this kind of farming.

The *stocking* of a pastoral farm consists of a breeding stock of sheep or cattle, and a yearly proportion of barren stock intended to be fed and sold at a proper age. A large capital is thus required to stock at first, and afterwards maintain, such a farm; for, although the quality of the land may not be able to support many heads of stock per acre, yet, as the farms are large, the number of heads required to stock a large farm is very considerable. The rent, when consisting of a fixed sum of money, is of no great amount per acre, but sometimes it is fixed at a sum per head of the stock that the farm will maintain.

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* It is to be regretted that neither the Old nor the New Statistical Account of Scotland gives the least idea of the *size* of the farms in any of the parishes described.

A *pastoral farmer* should be well acquainted with the rearing and management of cattle or sheep, whichever his farm is best suited for. A knowledge of general field culture is of little use to him, though he should know how to raise turnips and make hay.

2. Another kind of farming is practised on *carse* land. A carse is a district of country, consisting of deep horizontal depositions of alluvial or diluvial clay, on one or both sides of a considerable river; and may be of great or small extent, but generally comprehends a large tract of country. In almost all respects, a carse is quite the opposite to a pastoral district. Carse land implies a flat, rich, clay soil, capable of raising all sorts of grain to great perfection, and unsuited to the cultivation of pasture grasses, and, of course, to the rearing of live-stock. A pastoral district, on the other hand, is always hilly, the soil generally thin, poor, and various, and commonly of a light texture, much more suited to the growth of natural pasture grasses than of grain, and, of course, to the rearing of live-stock. Soil decides this kind of farming.

Being all arable, a *carse farm* is mostly stocked with animals and implements of labour; and these, with seed-corn for the large proportion of the land cultivated under the plough, require a considerable outlay of capital. Carse land always maintains a high rent per acre, whether it consists solely of money or of money and corn valued at the fiars prices. A carse farm, requiring much capital and much labour, is never of large extent, seldom exceeding 200 acres.

A *carse farmer* requires to be well acquainted with the cultivation of grain, and almost nothing else, as he can rear no live-stock; and all he requires of them are a few milch cows, to supply milk to his household and farm-servants, and a few cattle in the straw-yard in winter, to trample down the large quantity of straw into manure,—both of which classes of cattle are purchased when wanted.

3. A third sort of farming is that which is practised *in the neighbourhood of large towns*. In the immediate vicinity of London, farms are appropriated to the growth of garden vegetables for Covent-Garden market, and, of course, their method of culture can have nothing in common with either pastoral or carse farms. In the neighbourhood of most towns, garden vegetables, with the exception of potatoes, are not so much cultivated as green crops, such as turnips and grass, and dry fod-

der, such as straw and hay, for the use of cowfeeders and stable-keepers. The practice of this kind of farming is to dispose of all the produce, and receive in return manure for the land. And this constitutes this kind of farming a retail trade like that in town, in which articles are bought and sold in small quantities, mostly for ready money. When there is not a sufficient demand in the town for all the disposable produce, the farmer purchases cattle and sheep to eat the turnips and trample the straw into manure, in winter. Locality decides this kind of farming.

The chief qualification of an *occupant of this kind of farm*, is a thorough acquaintance with the raising of green crops,—potatoes, clover, and turnips; and his particular study is the raising of those kinds and varieties that are most prolific, for the sake of having large quantities to dispose of, and which, at the same time, are most suitable to the wants of his customers.

The *capital required for a farm of this kind*, which is all arable, is as large as that for a carse farm. The rent is always high per acre, and the extent of land not large, seldom exceeding 300 acres.

4. A fourth kind of farming is the *dairy* husbandry. It specially directs its attention to the manufacture of butter and cheese, and the sale of milk. Some farms are laid out for the express purpose; but the sale of milk is frequently conjoined with the raising of green crops, in the neighbourhood of large towns, whose inhabitants are whence daily supplied with milk, though seldom from pasture, which is mostly appropriated as paddocks for stock sent to the weekly market. But a true dairy-farm requires *old pasture*. The chief business of a *dairy-farm* is the management of cows, and of their produce; and whatever arable culture is practised thereon, is made entirely subservient to the maintenance and comfort of the dairy stock. The milk, where practicable, is sold; where beyond the reach of sale, it is partly churned into butter, which is sold either fresh or salted, and partly made into cheese, either sweet or skimmed. No stock are *reared* on dairy-farms, as on pastoral, except a few quey (heifer) calves, occasionally to replenish the cow stock; nor aged stock *fed* in winter, as on farms in the vicinity of towns. The bull calves are frequently fed for veal, but the principal kind of stock reared are pigs, which are fattened on dairy refuse. Young horses, however, are sometimes successfully reared on dairy-farms. Horse labour being comparatively little required thereon—mares can carry their young, and work with safety at the same time, while old pasture, spare milk, and whey, afford great facilities for nourishing young horses in a superior manner. Locality has decided this kind of farming on the large scale.

The purchase of cows is the principal expense of stocking a *dairy-farm;* and as the purchase of live stock in any state, especially breeding-stock, is always expensive, and live stock themselves, especially cows, constantly liable to many casualties, a dairy-farm requires a considerable capital. It is, however, seldom of large extent, seldom exceeding 150 acres. The arable portion of the farm supplying the green crop for winter food and litter, does not incur much outlay, as hay,—*that* obtained from old pasture grass,—forms the principal food of all the stock in winter. The rent of dairy-farms is high.

A *dairy-farmer* should be well acquainted with the properties and management of milch cows, the manufacture of butter and cheese, the feeding of veal and pork, and the rearing of horses; and he should also possess as much knowledge of arable culture, as to enable him to raise those kinds of green crops and that species of hay, which are most congenial to cows for the production of milk.

5. A fifth method of farming is that which is practised in most arable districts, consisting of any kind of soil not strictly carse land. This method consists of a regular system of cultivating grains and sown grasses, with the partial rearing, and partial purchasing, or wholly purchasing, of cattle; and no sheep are reared in this system, they being purchased in autumn, to be fed on turnips in winter, and sold off fat in spring. This system may be said to *combine the professions of the farmer, the cattle-dealer, and the sheep-dealer.*

6. A decided improvement on this system long ago originated, and has since been practised, in Berwickshire and Roxburghshire, in Scotland; and in Northumberland in England. The farmer of this improved system combines all the qualifications required for the various kinds of farming already enumerated. Rearing cattle and sheep, and having wool to dispose of, he participates in the activity of the stock-farmer. Cultivating grains and the sown grasses, he knows the culture of land as skilfully as the carse farmer. Converting milk into butter and cheese, after the calves are weaned, and indulging in the predilection for a bit of fine old pasture, he passes the summer and autumnal months as busily as the dairy-farmer. Feeding cattle and sheep in winter on turnips, he attends the markets of fat-stock as closely as the farmer in the neighbourhood of a town. Improving on the usual system of farming pursued in arable districts, by breeding and rearing *all* the stock fed on his farm—thereby eschewing the precarious trade of the dealer in stock—thus combining all the kinds of farming within the limits of his farm, he has it within his power every year to suit the particular demand of each market, and thereby enlarge the sphere of his

profits, and this he can do in any year more uniformly and certainly than any other class of his co-farmers.

To become a *farmer* of this *mixed husbandry*, a man must be acquainted with every kind of farming practised in the country. He actually practises them all. He prosecutes, it is true, each kind in a rather different manner from that practised in localities where the particular kind is pursued as the only system of farming; because each branch of his farming must be conducted so as to conduce to the welfare of the whole, and by studying the mutual dependence of parts, he produces a whole in a superior manner. This multiplicity of objects requires from him more than ordinary attention, and much more than ordinary skill in management. No doubt, the farmers of some of the other modes of farming become very skilful in adapting their practice to the situations in which they are actually placed, but his more varied experience increases versatility of talent and quickness of discernment; and, accordingly, it will be found that the farmers of the *mixed husbandry* prove themselves to be the cleverest and most intelligent agriculturists of the country.

The field of their operations, on both sides of the Tweed, has long been acknowledged to be not only the most highly cultivated portion of the kingdom, but that which contains the most valuable breeds of live-stock; and as the mixed husbandry cannot be carried on within very narrow limits, there, *large farms* exist. Less than 500 acres is too limited an extent. Live-stock and grain culture being equally attended to, each comprises a large proportion of the stocking, and the capital required to furnish both is considerable, though perhaps less than the last named system, in which the entire stock are purchased every year. The rents of both systems are about the same; and though both kinds are determined by no peculiarity of soil and locality like the others, the *mixed* is adapted by a happy form of constitution to most circumstances.

12. OF CHOOSING THE KIND OF FARMING.

> "Choice, being mutual act of all our souls, makes merit her election."
>
> TROILUS AND CRESSIDA.

These are the various kinds of farming pursued in this kingdom; and if there be any other, its type may, no doubt, be found in the mixed system just described. One of these systems must be adopted by the aspirant pupil for his profession. If he succeed to a family inheritance, the kind of farming he will follow will depend on that pursued by his predecessor, which he will learn accordingly; but if he is free to choose for himself, and not actually restricted by the circumstances of peculiar locality, or soil, or inheritance, then I would advise him to adopt the mixed husbandry, as containing within itself all the varieties of farming which it is requisite for a farmer to know.

If he is at liberty to take advice, I can inform him that the mixed husbandry possesses advantages over every other ; and practically thus:—in pastoral farming, the stock undergoes minute examination, for certain purposes, only at distantly stated times; and owing to the wide space over which they have to roam for food in pastoral districts, comparatively less attention is bestowed on them by shepherds and cattle-herds. The pastoral farmer has thus no particular object to attract his attention at home between those somewhat long intervals of time; and in the mean while time is apt to hang heavy on his hands.—The carse farmer, after the labours of the field are finished in spring, has nothing but a little hay-making and much bare-fallowing in summer, to occupy his mind until the harvest.—Dairy-farming affords little occupation for the farmer in winter.—The farmer in the vicinity of large towns, has almost nothing to do in summer, from turnip-seed to harvest.—Mixed-husbandry, on the other hand, affords abundant and regular employment at all seasons. Cattle and sheep feeding, and marketing grain, pleasantly occupy the short days of winter. Seed-sowing of all kinds affords abundant employment in spring. The rearing of live stock, sale of wool, and culture of green crops, fill up the time in summer until harvest; and autumn, in all circumstances, brings its own busy avocations at the ingathering of the fruits of the earth. There is, strictly speaking, not one week of real leisure to be found in the mixed system of farming;—if the short period be excepted, from assorting the lambs in the beginning of August to putting the sickle to the corn,—and that period is curtailed or protracted, according as the harvest is early or late.

If the young farmer is desirous of attaining a knowledge of every kind of farm work,—of securing the chance of profit every year,—and of finding regular employment at all seasons in his profession, he should determine to follow the mixed husbandry. It will not in any year entirely disappoint his hopes. In it, he will never have to bewail the almost total destruction of his stock by the rot, or by the severe storms of winter, as the pastoral farmer sometimes has. Nor can he suffer so serious a loss as the carse farmer, by his crop of grain being affected by the inevitable casualties of blight or drought, or the great depression of prices for a succession of years. Were his stock greatly destroyed or much deteriorated in value by such casualties, he might have the grain to rely on; and were his grain crops to fail to a serious extent, the stock might insure him a profitable return. It is scarcely within the bounds of probability, that a loss would arise in any year from the total destruction of live-stock, wool, *and* grain. One of them may fail, and the prices of all may continue depressed for years; but, on the other hand, reasonable profits have been realized from them *all* in the same year. Thus, there are safeguards against a total loss, and a greater certainty of a profitable return from capital invested in the *mixed*, than in any *other* kind of husbandry at present known.

13. OF SELECTING A TUTOR-FARMER FOR TEACHING FARMING.

> "These are their tutors, bid them use them well."
>
> TAMING OF THE SHREW.

After resolving to follow farming as a profession, and determining to learn the mixed, as the best system of husbandry, it now only remains for the young farmer to select a farmer who practises it, with whom he would wish to engage as a pupil. The best kind of pupilage is to become a boarder in a farmer's house, where he will not only live comfortably, but may learn this superior system of husbandry thoroughly. There is no better mode than this known at present of learning practical farming. The choice of locality is so far limited, as it must be in a district in which this particular system is practised in a superior manner. The largest district in which it is so practised, as I have already intimated, comprehends Berwickshire, Roxburghshire, and Northumberland. There, many farmers are to be found who accept pupils, amongst whom a proper selection should be made, as it would be highly injudicious to engage with one who is notoriously deficient in the requisite qualifications. The qualifications are numerous. He should have the general reputation of being a good farmer; that is, a skilful cultivator of land, a judicious breeder, and an excellent judge of stock. He should possess agreeable manners, and have the power of communicating his thoughts with ease. He should occupy a good farm, consisting, if possible, of a variety of soils, and situate in a tolerably good climate, neither on the top of a high hill, nor on the confines of a large moor or bog, but in the midst of a well cultivated country. These circumstances of soil and locality should be absolute requisites in a farm intended to be made the residence of *pupils*. The top of a hill, exposed to every blast that blows, or the vicinage of a bog, overspread with damp vapour, would surround the farm with a climate in which no kind of crop or stock could arrive at a state of perfection; while, on the other hand, a very sheltered spot in a warm situation, would give the pupil no idea of the vexations experienced in a precarious climate. His inexperience in these things will render him unfit to select for himself either a qualified farmer, or a suitable farm; but friends are never awanting to render assistance to young aspirants in such emergencies, and if their opinion is formed on a knowledge of farming, both of the farm and the personal qualifications of the farmer they are recommending, some confidence may be placed in their recommendations. And for the pupil's personal comfort, he should choose a residence where there are *no very young* children.

As a residence of one year must pass over ere the pupil can witness the course of the annual operations of the farm, his engagement at first should be made for a period of *not less* than a year; and at the expiry of that period he will, most probably, find himself inadequate to the task of managing a farm. The entire length of time he would require to spend on a farm, must be determined by the paramount consideration of his having acquired a competent knowledge of his profession.

14. OF THE PUPILAGE.

> "A man loves the meat in his youth that he cannot endure in his age."
>
> MUCH ADO ABOUT NOTHING.

Having settled these preliminaries with the tutor-farmer, the pupil should enter the farm—the first field of his anticipations and toils in farming—with a resolution to acquire as much professional knowledge, in as short a time, as the nature of the business which he is about to learn, will admit of.

The commencement of his tuition may be made at any time of the year; but since farming operations have a regular beginning and ending every year, it is obvious that the *most* proper time to *begin* to view them is at the *opening of the agricultural year*, that is, *in the beginning of winter*. It may not be quite congenial to the feelings of him who has perhaps been accustomed to pass his winters in a town, to participate for the first time in the labours of a farm on the eve of winter. He would naturally prefer the sunny days of summer. But the beginning of winter being the time at which every important operation is *begun*, it is essential to their being understood throughout, to *see them begun*, and in doing this, minor inconveniences should be willingly submitted to, to acquire an intimate knowledge of a profession for life. And, besides, to endeavour to become acquainted with complicated operations, after the *principal arrangements* for their accomplishment have been *completed*, is purposely to invite wrong impressions of them.

There is really nothing disagreeable to personal comfort in the business of the farm in winter. On the contrary, it is full of interest, inasmuch as the well-being of living animals then comes home to the attention more forcibly than the operations of the soil. The totally different and well marked individual characters of different animals, engage our sympathies in different degrees; and the more so, perhaps, of all of them, that they appear more domesticated when under confinement than at liberty to roam about in quest of food and seclusion. In the evening, in winter, the hospitality of the social board await the pupil at home, or at a friend's house, after the labours of the day are over. Neighbours interchange visits at that social season, when topics of conversation, common to all societies, are varied by remarks on professional occurrences and management, elicited by the modified practices of the different speakers, from which the pupil may pick up much useful information. Or should society present no charms to him, the quieter companionship of books, or the severer task of study, is at his command. In a short time, however, the many objects peculiar to the season which present themselves in the country in winter, cannot fail to interest him.

The very first thing to which the pupil should direct his attention on entering the farm, is to become well acquainted with its *physical geography*,—that is, its position, exposure, extent;—its fences, whether of wall or hedge;—its shelter, in relation to rising grounds and plantations;—its roads, whether public or private;—its fields, their number, names, sizes, relative positions, and supply of water;—the position of the farm-house and steading or farm-stead. Familiar acquaintance with all these particulars will enable him to understand more readily the orders given by the farmer for the work to be performed in any field. It is like possessing a map of the ground on which certain plans of operations are about to be undertaken. A plan of the farm would much facilitate an introduction to this familiar acquaintance. The *tutor*-farmer should be provided with such a plan to give to each of his pupils, but if *he* have it not, the pupil himself can set about constructing one which will answer his purpose well enough.

—an advantage which the usual systematic arrangement of agricultural works does not possess. The plan of a monthly calendar is a very deficient one ; because field operations are regulated not by separate months, but by seasons ; and the form of a dictionary is even more artificial still, as the multifarious topics demanding attention are thus necessarily thrown into the most heterogeneous juxtaposition, and more apt to confuse than to enlighten the mind of a pupil. The Author feels assured that were this second part of his work diligently studied *on a farm for the defined period recommended,* the Agricultural Pupil would find himself able to grapple with all practical details, and to manage for himself ;—by it the Country Gentleman also would be taught whether the course of operations on his home-farm were conducted by his land-steward to the best advantage ; and although it does not presume to *teach* practical Farmers, yet even they may find in it something to amuse, if not to instruct.

The *third* and concluding portion accompanies the young farmer into the world, where it acquaints him how to look about for a proper farm for himself. The qualifications of a good one are next pointed out, and the amount of capital required to furnish and conduct it. The Author having thus seen his Pupil fairly established in agricultural life, takes his leave, and bids him " good speed."

To avoid prolixity of description, numerous engravings and woodcuts of implements, and of particular practices of husbandry, have been introduced ; and portraits of animals of acknowledged celebrity have been given, as without reference to figures the distinguishing points of animals cannot be satisfactorily described. These illustrations, no doubt, considerably enhance the cost of the work, and this so far is an object of regret ; but to the proper accomplishment of the plan proposed by the Author, these were unavoidable, as he is firmly persuaded that, without such guide, no work on husbandry is worth the perusal—if practical knowledge be the reader's aim.

The perfecting of the Illustrations has required a combination of talent. The portraits of the animals—which were selected by the Author with much care and trouble from unexceptionable specimens of stock of their respective kinds—were painted in oil, from the life, by Mr JOHN SHERIFF, A.R.S.A., and engravings from them executed by Mr THOMAS LANDSEER of London. The drawings of the Implements of Husbandry have been made by Mr GEORGE SLIGHT, and the detailed descriptions of these have been furnished by Mr JAMES SLIGHT, of the Firm of Messrs JAMES SLIGHT and COMPANY, Agricultural Implement Makers, Leith Walk, Edinburgh, whose knowledge of the principles and practice of the science of mechanics is now well appreciated by the Agricultural Interest of Scotland. The few drawings of a peculiar character, such as of plants, and examples of remarkable and important field operations, have been executed by Mr GOURLAY STEELL, A.R.S.A., Edinburgh.

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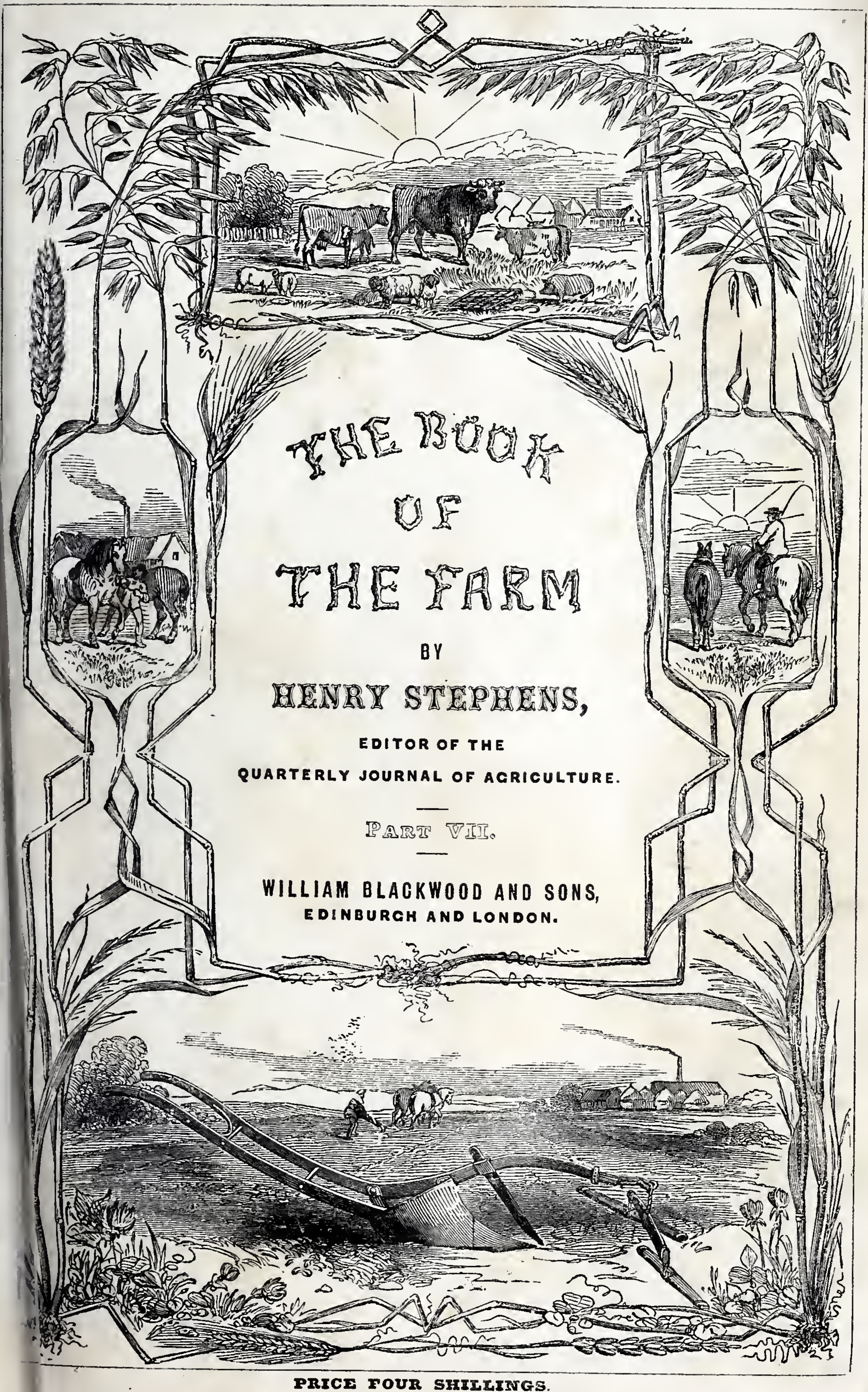

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Reader in Chemistry and Mineralogy in the University of Durham.

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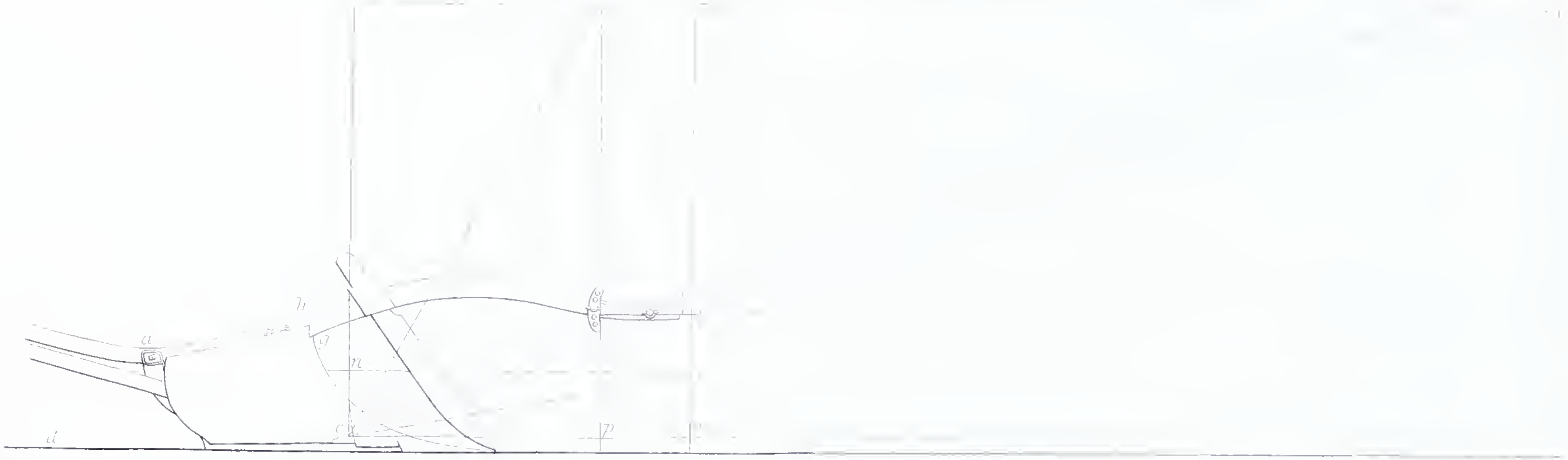

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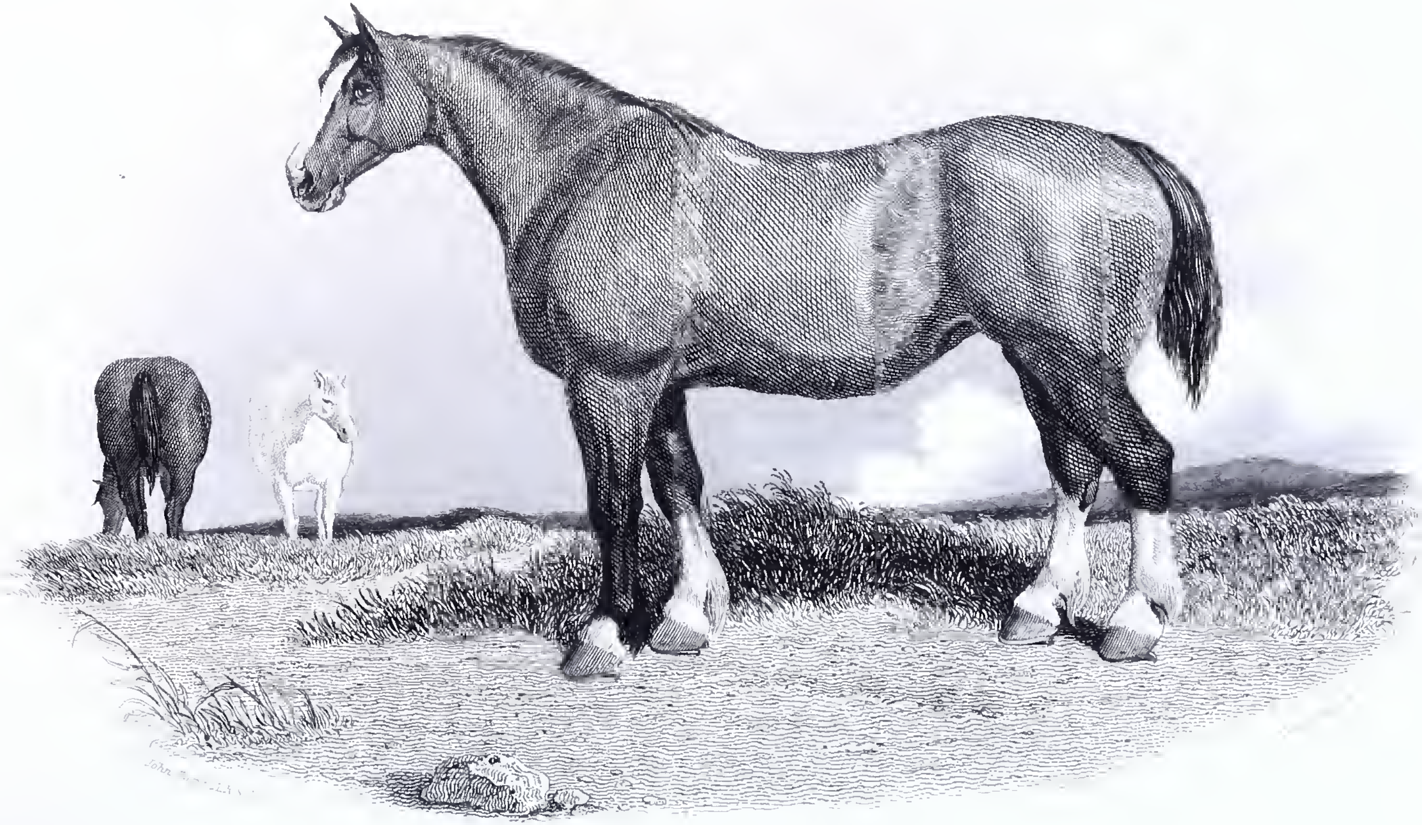

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PART VIII. WILL BE PUBLISHED ON THE FIRST OCTOBER,
When the monthly issue will be resumed.

EDINBURGH, 20*th June* 1842.

common drains may be taken at 9⅓d, or, including a charge to cover the proportion of main drains, 10d. per rood. Upon these data the following table has been constructed, the rood being 6 yards.*

Subsoils to which the distances are applicable.	Distances between the drains, in feet.	Roods per acre.	Cost per rood. in pence.	Cost per acre.		
				L.	S.	D.
For hard till subsoil, ...	10	228	10	9	10	0
	11	207	...	8	12	6
	12	190⅓	...	7	18	9
Stiff clay, ...	13	175⅓	...	7	6	3
	14	163⅓	...	6	16	3
Sandy clay, ...	15	152	...	6	6	7
	16	144	...	6	0	0
	17	135	...	5	12	6
	18	127⅓	...	5	6	3
	19	120	...	5	0	0
	20	114	...	4	15	0
Free stony bottom, ...	21	108	...	4	10	0
	22	103⅓	...	4	6	3
	23	99	...	4	2	6
	24	96	...	4	0	0
	25	91⅓	...	3	16	3
	26	87	...	3	12	2
	27	84	...	3	10	0
	28	81	...	3	7	6
	29	78	...	3	4	0
More open bottom, ...	30	75	...	3	2	6
	31	73⅓	...	3	1	3
	32	72	...	3	0	0
	33	69	...	2	17	6
	34	67⅓	...	2	16	3
	35	66	...	2	15	0
	36	64⅓	...	2	13	9
	37	61⅓	...	2	11	3
Irregular beds of gravel or sand, and irregular open rocky stratifications, ...	38	60	...	2	10	0
	39	58	...	2	8	9
	40	57	...	2	7	6†

(1010.) Mr James Carmichael, Raploch Farm, Stirlingshire, gives this tabular view of the expense of stone draining. He also calculates by the Stirlingshire rood of 36 yards, but I have reduced them in this, as in the case above, to the ordinary rood of 6 yards. The expense of carriage is taken at 5s. per day for man and horse, and the stones are supposed to be so far distant as only 5 loads can be fetched in a day:—

---

* Mr Smith calculates by the Stirlingshire rood of 36 yards.

† Smith's Remarks on Thorough-draining, p. 12–16.

	Distance of drains apart, in feet.	Depth of drain, in inches.	Width of bottom, in inches.	Roods of 6 yards, per acre.	Cost of carting and filling, per acre.			Cart-loads of stones, per acre.	Cost of carriage, per acre.			Total cost per acre.		
					L.	S.	D.		L.	S.	D.	L.	S.	D.
Aluminous clay.	18	20	5	134⅓	3	7	2	44⅘	2	4	9	5	11	11¼
	18	24	5	134⅓	3	12	10	44⅘	2	4	9	5	17	7½
	18	27	5	134⅓	3	18	4	44⅘	2	4	9	6	3	1½*

(1011.) As tiles themselves form an important item in the expense of *tile-draining*, it is necessary to state the cost of that indispensable article before detailing the expense of draining with them. Tiles may either be made by the drainer himself or purchased for the purpose from tile-makers who undertake to supply the market.

(1012.) Of those who have supplied themselves with tiles for draining, Sir James Graham of Netherby is a successful example. Before 1829 he erected a complete establishment for their manufacture, and also of bricks, and made an agreement with a tile-burner to supply him with the requisite number. He gave the contractor a cottage and garden, the use of tools, moulds, &c., belonging to the kiln, rent-free, all which he was bound to keep and leave in good order, and prepare the clay, provide coal and every thing necessary at his own expense, and furnish Sir James with the best made draining tiles at the following prices:—

3-inch tiles per 1000,	L.1	4	0
4	1	8	0
6	1	17	0
8	3	0	0

As a means of comparison with prices paid for tiles at the time at the sale-kilns of Carlisle and Wigton, from whence a very considerable quantity were used by farmers, the following statement may prove interesting:—

3-inch tiles per 1000,	L.2	2	0
4	2	12	0
6	4	4	0
8	8	8	0†

These tiles, however, were of the extraordinary length of 18 inches each.

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* Prize Essays of the Highland and Agricultural Society, vol. xii. p. 98.

† Ibid., vol. xii., p. 394

(1013.) The Duke of Buccleuch has erected tile-works on most of his extensive estates, from which his tenants are supplied at prime cost, namely, 3 inch tiles at 25s., and 4 inch at 32s. per 1000.*

(1014.) So long ago as 1823, the Duke of Portland introduced the manufacture of drain-tiles in Ayrshire. At that time they were sold for L.3 per 1000; in 1835 their price was reduced to 26s. 6d., and since then, by several important improvements which have been introduced into the manufacture, a still farther reduction has taken place. "It is not easy to establish a general rule for the selling price," says Mr James Taylor, factor to the Duke of Portland at Kilmarnock, "so as to meet every expense, as that must depend on the value of the land occupied by the work, the extent of ground taken up by roads, and many other incidents, such as the surface where the clay is taken from being rendered useless for cropping ever after, but which might have let for 30s. a year per acre. Taking the land at this value, estimating a road to be made of ¼ of a mile, and supposing the clay to last 10 years, I consider that tiles may be sold at the following rates, after making allowance for every possible expense :—

No. 1 tiles, 12 inches long, 5¾ inches wide, and 6½ inches high, inside measure, per 1000,	L.3	5	0
No. 2 tiles, 12 inches long, 5 inside, and 6 high,	3	0	0
No. 3 ... 12 ... ... 4 ... 5	2	10	0
No. 4 ... 12 ... ... 3 ... 4	1	5	0
No. 5 ... 12 ... ... 3 ... 3½	1	2	6
Large soles for Nos. 1 and 2 tiles, 12 inches long and 10 inches broad, per 1000,	1	5	0
Small soles for Nos. 3, 4 and 5 tiles, 12 inches long and 7 inches broad,	1	2	6

Nos. 1, 2, and 3 are tiles for main and sub-main drains, and Nos. 4 and 5 are those for common drains."†

(1015.) The prices of drain-tiles may be learned from what the manufacturers themselves state. Those demanded by Mr Robert Boyle, Ayr, were, in

	1836		1837
For large sewer tiles,	L.4 0 0	and	L.4 4 0
... main drain do.	2 13 0	...	3 0 0
... furrow-drain do.	1 6 0	...	1 7 6
... main drain soles,	1 10 0	...	1 12 6
... furrow-drain do.	1 0 0	...	1 2 6

The rise of price in 1837 was owing to a rise of price in coal. Mr Boyle makes these sensible remarks in regard to the market price of tiles. "The price of tiles," he says, "is of less importance than their durability, as *on this alone* their preference ought to depend. The best method, therefore, of making and burning them is of greater importance than their price, and a remunerating price must always be received, else the manufacturer will soon desist from working, or he will furnish an inferior article."* The tiles made by Mr Boyle are 13 inches long.

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* Prize Essays of the Highland and Agricultural Society, vol. xiii., p. 509.

† Ibid., vol. xii., p. 36.

(1016.) Mr Beart, Godmanchester, near Huntingdon, enters minutely into the particulars of manufacture, in order to arrive at a fair estimate of the selling price of tiles. He says, "The price at which tiles can be produced and sold by the manufacturer depends upon the system pursued, and the convenience for making a large quantity during the season. Where the system detailed in this essay is practised, and there is a sufficient extent of drying-shelves to keep a machine (one invented by Mr Beart himself) at work, the following is a statement of the average cost per 1000:—The expense of raising and preparing the clay and cost of fuel will vary; but the average expense of producing tiles per 1000, under ordinary cases, each tile to contain 100 cubic inches of clay, making a proportionate allowance for tiles containing less, and the price of coals being calculated at 17s. 6d. per ton, is as follows:—

Raising the clay, per 1000,	L.0 2 0	
Turning the same once over with water,	0 0 6	
Straw or sand for covering over the clay,	0 0 6	L.0 3 0
Grinding, and barrowing to the machine,	L.0 1 0	
Moulding by the machine, per 1000,	0 2 0	0 3 0
Setting and unloading the kiln, per 1000,	L.0 1 6	
Burning,	0 1 0	
Waste,	0 1 0	0 3 6
Cost of fuel per 1000, 1 ton of coal at 17s. 6d. per ton calculated to burn 3500 tiles,		0 5 0
Expense in the yard per 1000,		L.0 14 6

To which must be added rent, interest of money, and incidental expenses, say 2s. 6d per 1000, making the price 17s. per 1000, to which should be added 25 per cent. for manufacturer's profit, if the tiles are intended for sale, or 21s. 3d. per 1000. Where clay is of so mild a nature that it can be ground as it is raised, and in the neighbourhood of coal-works, the following deductions from the above estimate should be made:—

In raising and grinding, per 1000,	L.0 1 0
... straw,	0 0 6
... cost of fuel, from 1s. to 3s.	0 3 0
	0 4 6
Making the expense in the yard per 1000,	0 10 0
	L.0 14 6"†

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* Prize Essays of the Highland and Agricultural Society, vol. xii., p. 26.

† Prize Essays of the Highland and Agricultural Society, vol. xii., p. 44-5; and for a figure and description of Mr Beart's tile-machine, see p. 138 of the same volume.

While giving Mr Beart's own statement, I should mention that his tiles are only 12 inches long, and that those made with his machines in Fife and Mid Lothian are 15 inches, which would raise his price to 26s. 7d. per 1000. I should also mention, that doubts have been entertained of his estimates, from the circumstance that, though he has sent men to Scotland, who have built kilns on the plan which he recommends as a means of saving to the extent of 4s. or 5s. per 1000, yet in all cases they have failed of doing so.

(1017.) The important tile machine invented by the Marquis of Tweeddale makes tiles at the rate of 10,000 tiles a-day.[†] It has been assigned to a company, under the title of the Yester Patent Drain-Tile Company, who have erected several works throughout the kingdom: the one erected by them at Swinton, in Berwickshire, is on an extensive scale, and situate on a bed of clay of excellent quality for tile-making. A modification of the Yester machine has been, I believe, in use near Morpeth for some time past.

(1018.) Amongst the machines recently introduced for the manufacture of drain-tiles, that under the patent of Mr Ainslie, Redheugh, Mid-Lothian, stands pre-eminent, whether as regards the amount of its production, or for the quality of the article which it produces. There is a directness in the principle on which tiles are formed by this machine, that gives them at once greater solidity and soundness of texture than any process hitherto adopted. The principle of its action is this: The clay, prepared in the usual way by lifting and turning, is thrown into the hopper of the machine, and passing between a pair of smooth metal rollers, which mix and amalgamate the mass, besides crushing any stones that may be in the clay, it passes thence into a cylinder, where it is received into the coils of an endless screw, and by it is strongly pressed into a small chamber. The front of this chamber is changeable, and in it are formed the matrices, or rather *draw-plate* orifices, through which the continuous lines of tiles are expressed. This draw-plate may contain from 2 to 5 orifices, according to the size of tile, each orifice presenting an exact transverse section of the tile which it forms. The clay, then, on being pressed into the chamber at one side, is expressed through the orifice at the other side under great pressure; and as the tile receives at once the intended shape, there is no bending or fracture by any ulterior operation. The process, as here described, would produce a tile of indefinite length, but the machine is provided with an apparatus, driven by the tiles themselves that are being thus expressed,

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[*] For a figure and description of which, see p. 50, vol. xii. of the Prize Essays of the Highland and Agricultural Society.

which, by the passage of a wire across the lines of tile, cuts them off at a uniform length; they are then removed to the drying sheds, which are, for the purposes of this machine, made movable on railways, each shed containing a thousand tiles. Tiles of any size, from a 9-inch main-drain down to the smallest conduit, can be made by this machine, at rates varying from 14 large mains to 36 small conduit-tiles per minute, or from 8000 to 20,000 per day.

(1019.) A sort of drain-tile has lately been introduced by Lord James Hay of Seaton, Aberdeenshire. The composition of which it is formed is a *concrete*, consisting of *good* lime, *sharp* sand and gravel, which are mixed in the proportion of 1 bushel of lime shells to 2½ bushels of sand and 4 bushels of gravel, which in swelling give 8 bushels of composition that will make 120 tiles. The composition is run into moulds, in which it soon sets firm enough to be placed on boards, and the tiles become in a short time, according to the state of the air, in a sufficiently indurated state to be used. One man, aided with perhaps 4 others to supply the materials, will make 5000 tiles a day; but when the quantity of boarding is taken into consideration, I have great doubts of this process affording so cheap a tile as is represented of it: at all events it can only be practised in those localities which afford *sharp* sand and gravel in abundance,—substances which cannot be carried to a distance but at great expense; and experience has not yet sufficiently tested their durability even in the most favourable circumstances.

(1020.) With all these facilities for obtaining tiles, and the experience already acquired of making them suitable to particular purposes, the expense of tile-draining will be rendered considerably less than formerly. The current cost of using them, as well as stones, will, however, be best ascertained from the experience of drainers in the locality in which you may select your farm.

(1021.) In respect to the expense of draining by the Elkington method, no definite sum can be named which will apply to a definite extent of ground, such as an acre, as the extent of drainage in that system entirely depends on the quantity and direction in which water is met with under the surface of the ground. The cost, therefore, must be entirely estimated by the lineal rood, and the dimensions of the drains actually cut, and the difficulty or facility experienced in obtaining materials to fill them. These particulars, it is obvious, must vary according to circumstances, particularly in regard to the supply of tiles and stones, as the labour of cutting the ground does not much differ throughout the country.

(1022.) According to Mr Wilson's experience, the expense of the Elkington method of draining a retentive clay loam upon a retentive substratum of clay, with drains from 5 to 8 feet in depth, is on the average as follows:—

Expense of cutting 6 feet deep drains, 2½ feet wide at top, and 16 inches wide at bottom, the rood of 6 yards,	L.0	2	0
... of making the conduit, per rood,	0	0	2
... of quarrying, gathering, and carting 5 loads of stones, which cost (according to distance of carriage) from 8d. to 1s. 4d., average 1s. the load per rood,	0	5	0
... of filling in small stones, and the earth,	0	0	6
Average cost of rood,	L.0	7	8[*]

This sum may be considered as a fair charge for the Elkington method of draining by the rood of 6 yards.

(1023.) The expense of draining with tiles depending so much on the number and size of the drains, and the means of obtaining the materials for filling them, the subject will require to be considered somewhat in detail.

(1024.) The first instance I shall adduce of the cost of draining with *tiles* is derived from the experience of Sir James Graham of Netherby, Cumberland, who had drained with them to great extent prior to March 1829, when the following statement was published. I have reduced the expense into the *rood of* 6 *yards*.

With 3-inch tiles. Expense of cutting the drain on an average of 2 feet 9 inches deep, laying the tiles on slate or refuse tile, cutting and laying a turf over the tile, reversing and returning the surface soil, per rood of 6 yards,	L.0	0	3½
Expense of 18 tiles to the rood at the price paid at Netherby for 3-inch tiles, viz. 24s. per 1000,	0	0	5¼
Cost of carriage of tiles at an average distance of 3 miles, 3 rakes of a horse and cart and man a day, at 5s. a-day, the cart carrying 250 tiles each time,	0	0	1½
Cost of refuse slate or broken tile, and carriage,	0	0	0½
	L.0	0	10¾

With 4-inch tiles. Expense of cutting from 4½ to 5 feet deep drains, and in other respects the same as above,	L.0	0	5½
Expense of tiles, 18 to the rood, at 28s. per 1000,	0	0	6¼
Cost of carriage same as above,	0	0	1½
Cost of refuse slate or broken tile, and carriage,	0	0	0½
	L.0	1	1¾

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[*] Prize Essays of the Highland and Agricultural Society, vol. vii. p. 242.

With 6-inch tiles. Expense of cutting the same depth of drain as in the last case,	L.0	0	$5\frac{1}{2}$
Cost of tiles, 37s. per 1000,	0	0	8
Cost of carriage,	0	0	$1\frac{3}{4}$
Cost of refuse slate or broken tile, and carriage,	0	0	$0\frac{1}{2}$
	L.0	1	$3\frac{3}{4}$

Had the tiles been bought at that time at the public tile-works, the draining with the 3-inch tiles would have cost 1s. $2\frac{1}{4}$d., with the 4-inch tiles 1s. $6\frac{1}{2}$d., and with the 6-inch tiles 2s. $1\frac{3}{4}$d., the rood of 6 yards.*

(1025) The next instance I shall adduce of the cost of draining with tiles, is from the observations of Mr James Carmichael, Raploch Farm, Stirlingshire. The results are thrown into the tabular form, for the sake of easy reference, the rood being reduced to that of 6 yards, and the expense of carriage taken at 5s. a-day for man and horse and cart.

Soil.	Space between the drains, in feet.	Depth of drain, in inches.	Breadth of drain at the bottom, in inches.	Yards in the acre.	Cost of cutting and laying per rood of 6 yds., in pence.	Number of tiles per acre, at 3s. the 100.	Number of soles per acre, at 1s. 6d. per 100.	Cost of carriage per acre, in shillings.	Total cost.		
									L.	S.	D.
Aluminous clay.	15	20	5	968	$1\frac{1}{2}\,\frac{8}{12}$	2500	1250	11	6	7	$1\frac{3}{4}$
	15	22	5	968	$1\frac{3}{4}\,\frac{4}{12}$	2500	1250	11	6	9	$4\frac{1}{2}$
	15	24	5	968	$2\ \frac{8}{12}$	2500	2500	12	7	13	$7\frac{1}{2}$
	18	20	5	806	$1\frac{1}{2}\,\frac{8}{12}$	2080	1040	8	5	4	8
	18	22	5	806	$1\frac{3}{4}\,\frac{4}{12}$	2080	1040	8	5	6	$6\frac{1}{4}$
	18	24	5	806	$2\ \frac{8}{12}$	2080	2080	10	6	7	10
	21	20	5	691	$1\frac{1}{2}\,\frac{8}{12}$	1780	890	7	4	9	$8\frac{1}{2}$
	21	22	5	691	$1\frac{3}{4}\,\frac{4}{12}$	1780	890	7	4	11	$3\frac{3}{4}$
	21	24	5	691	$2\ \frac{8}{12}$	1780	1780	8	5	8	$11\frac{3}{4}$
Mixed clay.	15	18	5	968	$2\frac{1}{4}\,\frac{4}{12}$	2500	...	8	5	14	4
	15	20	5	968	$2\frac{1}{2}\,\frac{8}{12}$	2500	...	8	5	18	10
	15	22	5	968	$2\frac{3}{4}\,\frac{6}{12}$	2500	...	8	6	1	8
	15	24	5	968	$3\frac{1}{4}$	2500	1250	10	7	6	10
	18	18	5	806	$2\frac{1}{4}\,\frac{4}{12}$	2080	...	7	4	15	6
	18	20	5	806	$2\frac{1}{2}\,\frac{8}{12}$	2080	...	7	4	19	1
	18	22	5	806	$2\frac{3}{4}\,\frac{6}{12}$	2080	...	7	5	1	6
	18	24	5	806	$3\frac{1}{4}$	2080	1040	8	6	4	2†

It will be observed, in the above statement, that where soles are mentioned, their number is set down at only half of that of the tiles; and, in some instances, the soles are omitted altogether, thereby implying that they are not necessarily required in mixed clay. I trust I have said enough to dissuade you from adopting the opinion that soles can be dispensed with in any instance of tile-draining. (913.)

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* Prize Essays of the Higland and Agricultural Society, vol. vii. p. 397. † Ibid. vol. xii. p. 98.

(1026.) The experience of Mr Stirling of Glenbervie, Stirlingshire, in draining with tiles, gives the following results. I have retained the calculations by the *chain*, in order to shew you that there are various ways practised in this country of measuring drain-work. The drains are 30 inches deep in the furrow, 5 inches broad at the bottom, and 8 inches wide at 15 inches from the surface. The cost of cutting such a drain will vary from 8d. to 1s. 8d. the imperial chain of 66 feet, or $3\frac{2}{3}$ roods of 6 yards. The reason assigned by Mr Stirling for recommending this size of drain instead of a narrower is, that experience has not yet sufficiently proved what is the *smallest size that will be permanent.* The cost is estimated by Mr Stirling on the fact that 1 man and 2 horses will bring and string along the drains 960 tiles and soles a-day, from a distance varying from 4 to 5 miles. The prices of tiles and soles are taken at 40s. the 1000, of which 57 will lay a chain of 66 feet. The whole cost stands thus:—

Cost of cutting drain, per chain, . . .	L.0	1	2
... of 57 tiles and soles and carriage, . .	0	2	$9\frac{1}{2}$
... of returning earth, ...	0	0	$1\frac{5}{20}$
... of throwing on furrow-slice from between drains,	0	0	$0\frac{1}{2}$
	L.0	4	$1\frac{5}{20}$

In a tabular form the cost will stand thus by the imperial acre:—

Distance between the drains, in feet.	Number of chains, per acre.	Expense, per imperial acre.		
		L.	S.	D.
14	47.14	9	13	$5\frac{3}{4}$
16	41.25	8	9	$3\frac{1}{2}$
18	36.66	7	10	6
20	33.00	6	15	$5\frac{1}{4}$*

(1027.) A more recent authority on the expense of draining with tiles, as recent as October 1839, is the Marquis of Tweeddale, who has not only tile-drained extensively, but paid very great attention to every particular connected with it. His lordship's experience is embodied in the following table.†

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* Prize Essays of the Highland and Agricultural Society, vol. xii. p. 111–12.

† Quarterly Journal of Agriculture, vol. x. p. 439.

Depth of drains in feet.	Cost of cutting the rood of 6 yards lineal, in pence.	Distance between the drains in feet.	Roods of 6 yards in the acre.	Cost of cutting drains per acre.	Cost of filling in earth per rood of 6 yards, in pence.	Cost of filling in earth per acre.	Cost of laying tiles per rood of 6 yards.	Cubic yards in the drains per rood of 6 yards.	Cubic yards in the drain per acre.	Number of tiles per acre, of 14 inches in length.	Cost of tiles per acre, at 30s. the 1000.	Number of half-soles per acre.	Cost of soles per acre, at 15s. the 1000.	Total expense.
				£ s. d.		s. d.	s. d.				£ s. d.		s. d.	£ s. d.
2	3	15	161⅓	2 0 4	¾	10 1	4 0	1	161½	2489	3 14 8	1245	18 8	7 7 9
2	3	18	134⅔	1 13 7	¾	8 4¾	3 6	1	134¾	2072	3 2 1¾	1036	15 6¼	6 3 1¾
2	3	24	100⅚	1 5 2½	¾	6 3½	2 6	1	100⅚	1556	2 6 8	778	11 8	4 12 4
2	3	30	80⅔	1 0 2	¾	5 0	2 0	1	80¾	1244	1 17 3¾	622	9 3¾	3 13 10
2½	4½	15	161⅓	3 0 6	1	13 5½	4 0	1 10/27	221	2489	3 14 8	1245	18 8	8 11 3½
2½	4½	18	134⅔	2 10 4½	1	11 2½	3 6	1 10/27	184	2072	3 2 1¾	1036	15 6¼	7 2 9
2½	4½	24	100⅚	1 17 9¾	1	8 4¾	2 6	1 10/27	138	1556	2 6 8	778	11 8	5 7 0½
2½	4½	30	80⅔	1 10 3	1	6 8¾	2 0	1 10/27	112	1244	1 17 3¾	622	9 3¾	4 5 7¼
3	5½	15	161⅓	3 13 11	1¼	16 9½	4 0	1 20/27	282	2489	3 14 8	1245	18 8	9 8 0½
3	5½	18	134⅔	3 1 6½	1¼	13 11½	3 6	1 20/27	235	2072	3 2 1¾	1036	15 6¼	7 16 8
3	5½	24	100⅚	2 6 2½	1¼	10 5½	2 6	1 20/27	176	1556	2 6 8	778	11 8	5 17 6
3	5½	30	80⅔	1 6 11½	1¼	8 4½	2 0	1 20/27	141	1244	1 17 3¾	622	9 3¾	4 13 11¾
3½	7	15	161⅓	4 14 1	1½	20 2	4 0	2⅑	345	2489	3 14 8	1245	18 8	10 11 7
3½	7	18	134⅔	3 18 4	1½	16 9½	3 6	2⅑	287	2072	3 2 1¾	1036	15 6¼	8 16 3½
3½	7	24	100⅚	2 18 10	1½	12 7	2 6	2⅑	215	1556	2 6 8	778	11 8	6 12 2
3½	7	30	80⅔	2 7 0½	1½	10 1	2 0	2⅑	172	1244	1 17 3¾	622	9 3¾	5 5 9

(1028.) The only other instance I shall adduce of the expense of draining with tiles is derived from the experience of Mr George Bell, Woodhouselees, Dumfriesshire, one of the Duke of Buccleuch's tenants on the Langholm estate. The soil drained is that which is provincially termed "black-top," that is, a black mossy earth resting on a retentive clay subsoil, the upper soil being 10 or 18 inches in thickness. The drains are 30 inches deep in the furrows, and 15 feet apart, and were executed in November 1837 and 1838. One instance of draining only, out of several, shall be adduced, and I shall select the most costly, namely that executed over 13 acres in 1837. It is proper to premise, that the retentive clay subsoil, when dry, was thrown over the surface to mix with the mossy soil, and not returned into the drain. The cutting of the drains was contracted for, but the laying of tiles and the filling in of earth were done by the grieve on the farm, when the *soil was in a dry state;* this done, a furrow of the top soil, on each side of the drain, was ploughed in, as being an economical mode of filling in the earth. The soles consisted of Welsh slates, which were obtained in quantity at 16s. per 1000. The statement stands thus:—

Cost of 38,000 of 3-inch tiles, at 25s. the 1000,	L.47	10	0
... 1,557 of 4-inch tiles, at 32s. ...	2	10	5
... Cutting 2003 roods of drains of 6 yards each, at 3d. the rood,	26	0	9
... Slates for soles,	1	5	0
	L.77	6	2
... Carriage of 38,000 tiles, at 3s. 4d. the 1000,	6	6	8
... ... 1,557 ... 5s. ...	0	7	10
... 31 days' work of man and horse laying down tiles, straw and for covering them, at 5s. 6d. per day,	8	10	6
... Women loading and unloading the carts,	2	3	0
... 30 days' work of a man laying tiles and soles,	2	5	0
... 30 days' work of a woman, at 8d. per day,	1	0	0
... 3 days of plough-work, at 10s. per day,	1	10	0
Cost of draining 13 acres,	L.99	9	2
... ... 1 acre,	L.7	13	0

(1029.) If you carefully compare these statements of draining land with stones and with tile, you will find data most probably applicable to every circumstance which you may meet with in draining your own land. Should you not be able to find the individual fact you are in quest of, you will be able to arrive at it by calculation or inference from those given, and this is as near an approach as any general statement can make towards particular cases.

(1030.) In regard to the *comparative advantages of stone and tile* *drains*, it is impossible, in the present state of experience, to decide upon the superiority (if any) of either. I believe it to be quite possible to make a drain of either material to be permanent, and this being the case, the only question betwixt them is one of expense, which is partly dependent upon contingent circumstances, connected with locality. In one place stones are so plentiful, and tiles so distant, that it would be inconsistent to reject the former and procure the latter material; and, on the other hand, there are localities where tiles can be made on the spot, and stones cannot be obtained within many miles. But although the case of distance may be the same with the two sorts of materials, they are nevertheless not placed exactly in the same predicament, for tiles may be brought from a considerable distance to the locality in want of them at much less cost than stones. In the difference of the cost of carriage between the two sorts of materials, Mr Carmichael has shewn, by adducing the case of a man with a horse and cart being employed to draw the same quantity, say 5 loads a day, of both kinds of materials, that 1 cart-load of tiles and soles, each 14 inches in length, will lay upwards of 100 yards of a drain, 6 inches wide and of any depth; whereas, 1 cart-load, or cubic yard, of stones will only fill 18 yards of a drain 6 inches wide, to a depth of 12 inches, being an amount of carriage nearly 6 to 1 in favour of the tiles; and as carriage is the most laborious item in the cost of draining, it constitutes an important point for consideration, when you are about to undertake the drainage of your farm.

(1031.) The *next* important point for consideration is, whether the great outlay upon land occasioned by draining can be compensated for by increase of produce? for if no increase of produce, adequate to repay the large outlay, can be guaranteed, draining will not be persevered in. No one, beforehand, can give such a guarantee; but the experience of enterprising drainers, who have vested their capital in the experiment, has proved that draining—that is, effectual or thorough-draining, by whatever means that object is attained—not only compensates for the outlay incurred, but also improves the quality of the land and every thing that grows upon it. Examples of amelioration, as well as of profit, effected by draining, inspiring confidence and stimulating imitation, I shall adduce.

(1032.) The existence of moisture in the soil being most easily detected by its injurious effects on the crops usually grown upon it, the benefits of draining are also first indicated by the crops. On drained land, the straw of white crops shoots up steadily from a vigorous braird, strong, long, and at the same time so stiff as not to be easily lodged with wind or rain. The grain is plump, large, bright coloured, and thin skinned. The crop ripens uniformly, is bulky and prolific, more quickly won for stacking in harvest, more easily thrashed, winnowed, and cleaned, and produces fewer small and light grains. The straw also makes better fodder for live stock. Clover, in such land, becomes rank, long, and juicy, and the flowers are large and of bright colour. The hay from it wons easily, and weighs heavy to its bulk. Pasture-grass shoots out in every direction, covering the ground with a thick sward, and produces fat and milk of the finest quality. Turnips become large, plump, as if fully grown, juicy, and with a smooth and oily skin. Potatoes push out long and strong stems, with enlarged tubers, having skins easily peeled off, and a meally substance when boiled. Live stock of every kind thrive, become good tempered, are easily fattened, and of fine quality. Land is less occupied with weeds, the increased luxuriance of all the crops checking their growth. Summer fallow is more easily cleaned, and much less work is required to put the land in proper trim for the manure and seed; and all sorts of manures incorporate more quickly and thoroughly with the soil.

(1033.) Thorough-drained land is easily worked with all the common implements. Being all alike dry, its texture becomes uniform, and, in consequence, the plough passes through it with uniform freedom; and even where pretty large sized stones are found, the plough can easily dislodge them; and moving in freer soil, it is able to raise a deeper furrow-slice; and the furrow-slice, on its part, though heavy, crumbles down and yields to the pressure and friction of the plough, forming a friable, mellow, rich-looking mould. The harrows, instead of being held back at times, and starting forward, and oscillating sideways, swim smoothly along, raking the soil into an uniform surface and entirely obliterating foot-marks. The roller compresses and renders the surface of the soil smooth, but leaves what is below in a mellow state for the roots of plants to expand in. All the implements are much easier drawn and held; and hence, all the operations can be executed with less labour, and of course more economically and satisfactorily on drained than undrained land.* All these effects of draining I have observed from my own experience.

(1034.) "It is gratifying," says Mr James Black, in reference to the effects of the Elkington mode of draining on the estate of Spottiswoode in Berwickshire, "to be enabled to state, that the general result of the operations has been such as to bear out the calculations of the engineer, and to justify the most sanguine hopes that could have been formed of a valuable improvement. Bursts and springs, which formerly disfigured entire fields, and which rendered tillage precarious and unprofitable, are now not to be seen; and swamps, which were not only useless in themselves, but which injured all the land around them, have been totally removed. The consequence is, that tillage can now in those parts be carried on without interruption, and with nothing beyond the ordinary expenditure of labour and manure; and a sward of the best grasses, raised and continued on spots which formerly only produced the coarsest and least valued herbage."

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* See papers by me on this subject in the Quarterly Journal of Agriculture, vol. vi. p. 526, and vol. viii. p. 171–2.

(1035.) "Besides those effects," he continues, "which were, in a certain degree, to be expected as a consequence of laying land dry, others have resulted, which, it must be confessed, were not at first so clearly contemplated. The hurtful effect of rime or hoar-frost on vegetation is a circumstance familiar to all who have had experience of cold and elevated districts, or of low lands subject to exhalations, or excluded from the influence of the sun and currents of air. The rime, in these swampy hollows of which mention has been made, was found, even in the warmest seasons, to be productive of serious inconvenience and injury to the growing crops; and that chiefly at the period when the grain was approaching to its mature state. This evil, it may be said, has been removed, or at least is now so little felt, that the grain produced in these very hollows has, for many years, escaped the smallest perceptible injury from this cause."

(1036.) "Another effect," he adds, "which was still less contemplated, and has not less agreeably resulted from the drainage undertaken, has been the improvement of the trees and woodlands in the property. Considerable difficulty was experienced in nursing up the trees in the first stages of their growth; and often individual trees grew up with stunted stems, and covered with parasitical plants, which always indicate unhealthy growth. Latterly this evil has been infinitely less felt, owing, in a material degree certainly, to the superior management of the woods themselves, but obviously also, in a certain degree, to the greater dryness of the ground. Since several of the woods have been laid dry by under-drainage, the ground, in many of the hollows, has sunk so much, that the roots of the trees have been left standing up bare above the surface, with the appearance of crows' feet; and parts which were boggy and marshy, and in which sportsmen used to stick fast in hunting, are now perfectly solid, with a good sward of grass, over which they may now gallop with freedom."[*]

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[*] Prize Essays of the Highland and Agricultural Society, vol. vii. p. 234-6.

(1037.) All these characteristics of draining are nothing more nor less than the properties of *good* land, which are here observed on the same soil that formerly exhibited the properties of *bad;* thus proving that draining places bad land—that is, natural land that rests on so retentive a subsoil as to detain surface-water until it stagnates—in the same state as naturally good land,—that is, natural land that rests on a subsoil naturally pervious to surface-water. Draining, in thus curtailing the limits of bad, produces the immediate effect of extending the limits of good soil.

(1038.) But draining has been found beneficial not only to the soil itself, to the processes of labouring it, to the climate in reference to crops, and to the growth of trees, but also to the health of the labouring population. Dr Charles Wilson, Kelso, when comparing the health of the labouring population of the district of Kelso in two decennial periods, from 1777 to 1787 and from 1829 to 1839, came to this conclusion in regard to the effect of draining, that " our attention is here justly attracted by the extraordinary preponderance of cases of ague in the first decennium, where they present an average of $\frac{1}{7}$ of all cases of disease coming under treatment; and a closer examination of the separate years shews this proportion rising more than once to even as high as $\frac{1}{5}$; while, in the second decennium, the average proportion is only $\frac{6}{100}$ of the general mass of disease. Ague, then, as is well known to the older inhabitants of the district, was *at one time regularly endemic amongst us;* affecting every year a varying, but always a considerable portion of population, and occasionally, in seasons of unusual coldness and moisture, spreading itself extensively as an endemic, and shewing its ordinary tendency, under such circumstances, of passing into a continued and more dangerous type. Ague was not usually in itself a disease of great fatality, the deaths recorded at the Dispensary having been only 1.81 per cent. of the cases treated,—a sum which denotes its absolute mortality, whilst its relative mortality was 0.26, when viewed in connection with that from all other diseases. Still, if we keep in view how frequently it was known to degenerate into fevers of a worse form, and how often it terminated in jaundice, " obstruction of the viscera of the abdomen," and consequent dropsies; or even if we take into consideration the frequency of its recurrence, and the lengthened periods during which it racked its victims, we shall see much reason to be thankful that a plague so universal and so pernicious has been almost wholly rooted out from amongst us. Those who recollect what has been stated of the former swampy nature of the soil in our vicinity, and of the *extensive means which have been adopted for its drainage*, will, of course, have no difficulty in understanding why ague was once so prevalent, and under what agency it should now have disappeared; and will gratefully acknowledge the *twofold value of those improvements, which have at once rendered our homes more salubrious, and our fields more fruitful*."*

(1039.) But the most palpable advantage of draining land is the *profit* which it returns to the farmer. A few authenticated instances of the profits actually derived from draining will suffice to convince any occupier of land of the benefits to be derived from it. "I am clearly of opinion," says Mr North Dalrymple of Cleland, Lanarkshire, "that well-authenticated facts on economical draining, accompanied with details of the expenses, value of succeeding crops, and of the land before and after draining, will be the means of stimulating both landlords and tenants to pursue the most important, judicious, and *remunerating* of all land improvements. The statements below will prove the advantages of furrow-draining; and as to the *profits* to be derived from it, they are *great*, and a farmer has only to drain a 5-acre field to have ocular proof upon the point."†

(1040.) Without entering into all the minutiæ of the statements given by Mr Dalrymple, it will suffice here to exhibit the general results. 1. One field containing 54 Scots acres cost L.303, 7s. to drain, or L.5, 12s. per acre. The wheat off a part of it was sold for L.11, and the turnips off the remainder for L.25 : 13 : 4 per acre. The soil was a stiff chattery clay, and let in grass for 20s. an acre; but in 1836, after having been drained, it kept 5 cheviot ewes, with their lambs, upon the acre. 2. Another field of 18 acres cost L.5, 9s. the acre to drain. The wheat off a part of it fetched L.13, the potatoes off another part L.15, 15s., and the turnips off the remainder L.21 per acre. The land was formerly occupied with whins and rushes, and let for 12s. the acre; but when let for pasture after being drained, Mr Dalrymple expected to get 50s. an acre for it. It may be mentioned, that the drains made by Mr Dalrymple were narrow ones, 30 inches in depth, filled 18 inches high with stones or scoriæ from a furnace, and connected with main drains, 36 inches deep, furnished with tiles and soles.‡

(1041.) Mr James Howden, Wintonhill, near Tranent, in East Lothian, asserts from his experience, that although drains should cost as much as

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* Quarterly Journal of Agriculture, vol. xii., p. 328.

† Ibid., vol. viii., p. 319.

‡ Ibid., vol. viii. p. 320.

L.7 the acre, yet on damp heavy land thorough draining will repay from 15 to 20 per cent. on the outlay.*

(1042.) A farmer in Lanarkshire, who thorough-drained one-half of a 4-acre field, and left the other half undrained in 1838, planted the whole field with potatoes, and from the drained portion realized L.45, whilst the undrained only realized L.13, the Scotch acre.†

(1043.) A very successful instance of drainage is related to have taken place on the estate of Teddesley Hay, near the river Penk, in Staffordshire, belonging to Lord Hatherton, under the direction of his agent Mr Bright. The soil is represented of a light nature, resting on a subsoil of stiff clay. The results are these :

Quantity of land drained.	Value of the land in its original state.		Cost of draining.	Value of the land in its present state.	
	Per acre.	Annual value.		Per acre.	Annual value.
A. R. P.	s.	L. s. D.	L. s. D.	s.	L. s. D.
78 1 36	10	39 4 3	262 15 0	27	105 18 9
19 1 32	10	9 14 6	74 9 8	35	34 0 9
38 0 3	16	30 8 3	52 14 2	40	76 0 9
82 2 2	15	61 17 8	346 16 4	30	123 15 4
30 3 24	10	15 9 0	121 5 8	35	54 1 6
81 1 34	8	32 11 8	153 16 4	22	89 12 2
36 3 16	10	18 8 6	142 8 0	30	55 5 6
33 0 0	8	13 4 0	80 5 2	26	42 18 0
10 2 33			90 8 0	50	26 15 3
10 0 8				21	10 11 0
9 0 0	12	5 8 0	76 9 8	30	13 10 0
15 0 11	16	12 1 0	41 9 4	33	24 17 3
21 2 10	15	16 3 5	66 0 0	30	32 6 10
467 0 9		254 10 9	1508 17 4		689 13 1

Here is an increase of L.435 : 2 : 4 a-year by draining, with an expenditure of only L.1508 : 17 : 4, or 29 per cent. on the capital expended.‡

(1044.) Mr George Bell's experience of the good effects of thorough draining on turnips gave, in the instance of Aberdeenshire yellow bullock turnips, which were raised from bone-dust in 1838, a crop of 16 tons 16 cwt, on 2 acres; whereas the same extent of undrained land only produced 6 tons 4 cwt. the acre. In 1839, the produce of potatoes on drained land was 175 cwt. the acre, whereas that on undrained land was only 70 cwt.

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* Quarterly Journal of Agriculture, vol. viii., p. 321.

† Ibid., vol. x., p. 271.

‡ On Land-Drainage, &c., p. 12.

(1045.) I should here remark that, when drains are executed on stubble or lea ground, the first corn crop after draining is not sensibly increased in produce; but after the ground has been fallowed, that is, ploughed, properly wrought, and manured, a very sensible increase of crop takes place. Thus, in the instance of Mr Bell's experience, in 1838, the increase on the oat crop was only 5 bushels, on 2 acres, more on the drained than the undrained land; and in 1839, 9 acres drained produced 258 bolls, and 6¾ acres undrained produced 192 bolls. These results are very much less than those obtained from green crops when the land had been effectually laboured after the operation of draining.

(1046.) Other instances of successful draining could be adduced, such as the improvements of Mr Denison on his property of Kilnwick Percy, and on Hutten Bushel by the Rev. Mr Croft,[*] and last, though not least, by Sir James Graham of Netherby,[†] and the Marquis of Tweeddale at Yester; and I might adduce my own humble doings in that way, but enough, I presume, has been already stated to shew you the value of draining.

(1047.) But although remarkable instances of increase and of profit are immediately derived from draining land, it must not be received as an undoubtedly established fact, that the great increase will continue ever afterwards without diminution. Effectual draining makes the greatest impression at first on soils much under the influence of water, whether they be naturally good or bad; but from the nature of things, naturally good land should possess more stamina than bad, and accordingly, experience has long since proved, that good land effectually drained maintains its superiority over bad for a period of years, even although the inferior should exert itself more for a few years after being drained. Although I express myself in these terms, I by no means acquiesce in the opinion expressed on a similar view of the subject by Mr Peter Thomson, Hangingside, Linlithgowshire; yet there is doubtless much truth in what he states, and such sentiments you should keep in mind, in order to check over sanguine expectations excited by recent improvements. "Thorough-draining, like every other improvement," says Mr Thomson, "has the best return from good soil. When executed on bad land, the outlay will not be repaid, and no little disappointment will be the certain consequence of much that has been already done upon weak soils. Weak land, upon being relieved from an excess of moisture, makes an extraordinary exertion, and in the course of the first rotation of crops yields considerably beyond what it formerly did; but in the course of the second rotation, the produce becomes considerably diminished, and when laid down to pasture, the finer description of grasses give way to those indigenous to the soil." These remarks I conceive to be more applicable to the abuse than to the proper use of draining, for I cannot coincide with the opinion that any bad land will not repay the expense of *thorough*-draining, because experience hitherto leads our convictions the other way; and although the coarser grasses may predominate on bad land after drainage, they will only do so in permanent and not in arable pasture, and even there they will be finer than they were; and it is any thing but good farming to allow land that is naturally weak to remain long in grass, immediately after being first drained. Here is an instructive table, constructed by Mr Thomson, to shew the produce of an imperial acre of both inferior and good land, beyond the first rotation of cropping, before and after thorough-draining; and the results are, that the produce fell off in both conditions of soil in the second rotation, though the falling off was less on the good than the inferior soil; but even on the inferior soil the return, on the average, from all the species of crops, is equivalent to at least 10 per cent. on the largest sum that is incurred in thorough-draining.

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[*] Journal of the Royal Agricultural Society of England, vol. ii., p. 35.

[†] Ibid., vol. i., p. 32; and Prize Essays of the Highland and Agricultural Society, vol. vii., p. 388.

Kinds of Crops.	On inferior land.			On good land.		
	Before being drained.	After being drained.		Before being drained.	After being drained.	
		In the 1st rotation.	In the 2d rotation.		In the 1st rotation.	In the 2d rotation.
	Bush. Pks.	Bush. Pks.	Bush. Pks.	Bush. Pks.	Bush. Pks.	Bush. Pks.
Barley, .	23 3	33 1	29 1¼	27 3	38 0	36 2
Oats, . .	35 2¾	47 2¼	44 1½	38 0	52 1¼	50 0
	L. S. D.	L. S. D.	L. S. D.	L. S. D.	L. S. D.	L. S. D.
Grass by the acre.	1 3 9	2 11 6	1 19 8	1 11 8½	3 19 3	3 11 4*

It would be of essential service to future drainers were those of the present day to ascertain the comparative produce derived from drained good and bad land, for a series of rotation of crops, so as the smallest amount of expenditure which bad land would require to be laid out in draining it, to render it profitable to the drainer, may be clearly ascertained.

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* Prize Essays of the Highland and Agricultural Society, vol. xiii. p. 297-8.

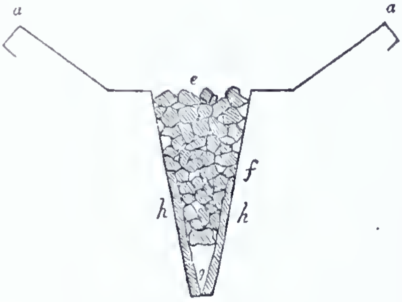
(1048.) An important precaution in regard to draining must be given you in regard to the *mode of conducting* draining operations. I have frequently observed in bad weather in winter a great extent of drains cut and left open for an indefinite length of time, in the intervals of which rain and snow have fallen and brought down parts of the sides into the bottom. The spade-work, too, is frequently roughly and slovenly executed, whereas it should be done neatly and correctly in every size of drain. I have also observed drains circumscribe comparatively small boulder stones, instead of the stones being removed, and the drain carried forward in a straight line. The most retentive part of the earth from the bottom of the drain is often thrown upon the edge of the drain, whereas being put into the drain after some of the more open portions, it, of course, should be thrown at first farthest from the edge. The tiles are frequently laid down in a very careless manner, instead of being placed as near the hand of the person who lays them as possible, on the opposite side of the drain on which the earth is thrown out. Soles of any kind are too frequently neglected to be used. And to reach the climax of negligence in the whole process, a long time is frequently allowed to elapse before the earth is returned again into the drain. Every one of these negligent practices you should scrupulously avoid; and as they entirely originate in neglecting to exercise a strict superintendence over the labourers who have undertaken to perform the work, either by day's wages or by the piece, the farmer himself is to blame in allowing them to exist; and constant superintendence is required to avoid them. For example. If the same set of men undertake to cut the drains and lay the tiles, which is by far too common a practice, a wet state of weather is pleasanter for them to cut the solid ground than to lay the tiles, and so they continue, day after day, as if they had nothing else to do but to cut the drains. The consequence is, that a large extent of drain is left exposed to the weather, which being supposed to be wet, the chances are that much of the sides fall in. If the rain continue, the workmen can neither bottom out the drain nor lay the tiles, and the matter becomes worse daily. Then a sudden frost comes, and moulders down still more of the earth from both sides, which, absorbing the rain that falls, is converted into sludge that cannot be taken out until it becomes firm. A fine day or two succeed, which induce the men to lay the soles and tiles, and they continue laying them, as if they were certain that the dry weather will continue, until they are ready to return the earth into the drain. This earth they find too wet one day to put into the drain, and too hard with frost in another, and so the laid tiles get leave to lie exposed to whatever change of weather may happen to come next, with a slight sprinkling of straw or other substance above them. In all these various states I have seen drains exposed for weeks together.

(1049.) Now, it is certain that the occurrence of all this negligence would be prevented were a strict superintendence exercised over the workmen. When left to the dictates of their own will, they will naturally execute that part of the work which, in reference to the state of the weather, is most conducive to their own interest, if they are working by the piece, or which is pleasantest to their own feelings, if working on day's wages, irrespective of the ultimate consequences in which their choice may involve the drain. They would not willingly see their work injured; but as they are unable to predict the state of the weather beyond the day before them, it is surely worse than folly, on the part of the farmer, to grudge the cost of constant superintendence over one of the most permanent operations that can be performed on a farm. The time of a grieve or steward is considered thrown away when superintending drainers. No doubt the grieve's time can be fully occupied elsewhere, and there is little fear of men on piece-work doing less work each day than will secure them good wages, but it is not the quantity of work done in draining which constitutes the most material consideration for the farmer; it is its *quality* and *efficiency;* and to obtain these, proper superintendence over workmen is requisite. If the grieve have not sufficient leisure, let another and competent person be appointed to superintend, and if he also undertake to lay the tiles, in so far a saving will be effected in that part of the operations, whilst his superintendence will oblige the workmen to cut the drains and return the earth whenever the state of the drains is best adapted for each operation; but if they are not bound to return the earth, he should have the power to direct the steward of the farm to send ploughs for the purpose when required. When such a system of superintendence is begun and persevered in, it is much easier to conduct the whole work by it than when work is done in an irregular manner, and it possesses the great advantage of securing every part of the work, in the most proper time against the effects of weather, and also in the most satisfactory condition.

(1050.) Besides the methods of draining land with stones and tiles as have just been described to you at much length, there are other methods which deserve your attention, because they may be practised in particular situations in an economical manner. I do not believe that the methods I am about to mention are so effectual as those I have described, still I have no doubt any one of them may be made effectual in situations where the materials recommended are abundant. Besides, it is well to have a choice of methods of performing the same operation, that your judgment may be exercised in adopting the one most advisable in the circumstances in which you are placed; whilst, at the same time, you should never lose sight of this maxim in agriculture, that that operation is most economically executed, or, at all events, affords most satisfaction in the end, which is executed in the most efficient manner, both as regards materials and workmanship, and the maxim applies to no operation so strongly as to draining, because of its permanent nature. The methods of draining which I am about to mention apply to every species of soil, from light loam, the heaviest clay, to bog.

(1051.) The first method which I shall notice is applicable to a *tilly subsoil which draws water* a little, situate in a locality in which *flat stones are plentiful and sufficiently cheap*. Suppose a piece of land, containing 2 ridges of 15 feet in width, which had been gathered up from the flat, and in this form of ploughing, as you have already learned, there is an open furrow on each side of a ridge (824.). The drains are made in this manner: Gather up the land twice, by splitting out a feering in the crown of each ridge, and do it with a strong furrow. Should the 4-horse plough have been used for the purpose, the open furrow will be left 16 inches wide at bottom, and if the furrow have been turned over 12 inches in depth, and the furrow-slice laid over at the usual angle of 45°, the tops of the furrow-slices on the furrow-brow will be 32 inches apart, as from *a* to *a*, fig. 187. After this ploughing the spade takes out a trench from the bottom of the open-furrow 8 inches wide at top *e*, 16 inches deep by *f*, and 3 inches wide at bottom at *g*. The depth of the drain will thus be 32 inches in all below the crowns of the gathered up ridges. The drain is filled by two flags *h h* being set up against its sides and meeting in the bottom at *g*; and they are kept asunder by a large stone of any shape, as a wedge, but large enough to be prevented by *h h* descending farther than to leave a conduit *g* for the water. The remainder of the drain is filled to *e* with small riddled stones with Mr Roberton's drain-screen or with clean gravel. The stones are covered over with turf and earth like any other drain, or with small stones beaten down firmly. The expense of this method of draining is small: the spade work may be executed at 1d. the rood of 6 yards, and of an imperial acre, containing 161$\frac{1}{3}$ of such roods, the cutting will cost 13s. 5$\frac{4}{12}$d. The flags, at 1 inch thick and 6 inches broad, will make 15 tons per acre, at 4d. the ton, will cost 5s. more. The broken stones, to fill 9 cubic feet in the rood of 6 yards, at 2$\frac{1}{4}$d. per rood, will cost L.1 : 10 : 3$\frac{1}{2}$ more; making in all about L.2 : 8 : 8 the acre, exclusive of carriage and ploughing, which, though estimated, will yet make this a cheap mode of draining land so closely as 15 feet apart.*

Fig. 187.



THE FLAT STONE DRAIN.

(1052.) The draining of *mossy light soils* where *peat is plentiful* may be effected in this way. The peats are made somewhat of the shape of drain-tiles but more massive, as may be seen in fig. 188. They are laid in the drain one *a* like a tile-sole, and another inverted upon it, as *b*, like a drain-tile, leaving a round opening between them for the passage of the water. These peats are cut out with a spade-tool, contrived some years ago by Mr Hugh Calderwood, Blacklyres, Ayrshire. The spade is easily worked, and forms a peat with one cut, without any waste of materials; that is, the exterior semi-circle *b* is is cut out of the interior semi-circle of *a*. A man can cut out from 2000 to 3000 peats a-day with such a spade. The peats are dried in the sun in summer, with their hollow part upon the ground, and are stacked until used; and those used in drains have been found to remain quite hard. The invention of this spade, of which a figure, 189, is here given, tends to make the draining of moorish soils more practicable than heretofore, and it may be done at $\frac{1}{5}$ or $\frac{1}{4}$ of the expense of ordinary drain tiles. The frequent want of clay in upland moory districts renders the manufacture of drain-tiles on the spot impracticable, and their carriage from a distance a serious expense.*

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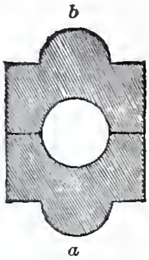
* Quarterly Journal of Agriculture, vol. vii. p. 245.

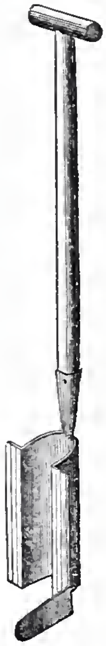
Fig. 188.



THE PEAT-TILE FOR DRAINS.

(1053.) Sir Joseph Banks alludes to the filling up of drains in bogs, which had been executed at great expense at Woburn, by the growth of the marestail (*Equisetum palustre*). On examining the plant, Sir Joseph found " its stem under ground a yard or more in length, and in size like a packthread; from this a root of twice the size of the stem runs horizontally in the ground, taking its origin from a lower root, which strikes down perpendicularly to a depth I have not hitherto been able to trace, as thick as a small finger."† I have frequently met with the roots or stems of the marestail under ground, which, on being bisected by the drains, poured out a constant run of water for some time, but, when fairly emptied of it, and no longer receiving support by a due supply of moisture from above, they withered away. Although there is no doubt that in the case mentioned by Sir Joseph Banks, that the roots of the marestail penetrated deeper than the drains, yet the circumstance of their sending upwards shoots which grew " along the openings left for the passage of water," proves that sufficient moisture had been left near the surface of the bog, notwithstanding the draining, to support the plant in life; in short, that the bog had been insufficiently drained, otherwise the rivation of support by moisture to the stems at the surface would inevitably have destroyed the vitality of the roots below.

Fig. 189.



THE CALDERWOOD PEAT-TILE SPADE.

(1054.) A plan similar to that described in (1051) may be practised on *strong clay land*. The open-furrow is formed in the same manner with the plough, and being left 16 inches in width, the spade work is conducted in this manner. Leave a scarcement of 1 inch on each side of the open-furrow left by the plough, as seen below *a a*, fig. 190, and cut out the earth, 14 inches wide, perpendicularly, and 10 inches deep, as at *b b*. Then cast out from the bottom of this cut with a spade 3 or 4 inches wide, a cut 5 inches or more in depth *c*, leaving a scarcement of 5 inches on each side of the bottom of the former cut *b b*. The bottom of the small cut will be found to be 32 inches below the crowns of the ridges, when twice gathered up with a strong furrow. The drain is filled up in this way: Take flag-stones of 2 or 3 inches in thickness, as *d*, and place them across the opening of *c* upon the 5-inch scarcements, left by the narrow spade; they need not be dressed at the joints, as one stone can overlap the edges of the two adjoining, and they thus form the top of a conduit of pure clay in which the water may flow. As the water is made to flow immediately upon the clay, it is clear that this form of drain can not be regarded as a permanent one; though a flag or tile sole laid on the bottom of the cut *c* would render it much more durable. The cutting of this form of drain, the workmen having to shift from one tool to another, will cost 1½d. the rood of 6 yards, which at 15 feet apart make 20s. 2d. the acre. The flags for covers will be 12 tons at 4d. per ton, 4s. more, in all 24s. 2d., but with 10 tons of soles the cost will be 3s. 4d. more, or 27s. 6d. the acre, exclusive of the carriage of stones and the labour of the plough. After the *joinings* of the flags are covered over with turf, the earth may be returned into the drain with the plough, but with precaution, and probably with the previous assistance of the spade; but, after all, the probability is, that *flat* stones cannot be easily obtained in the neighbourhood of strong clay, though this *form* of drain may be adopted in any subsoil where flat stones are abundant.*

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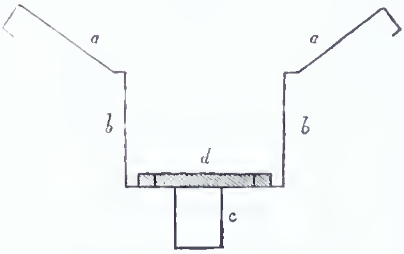
* Quarterly Journal of Agriculture, vol. vii. p. 247.

† Communications to the Board of Agriculture, vol. ii. p. 349.

Fig. 190.

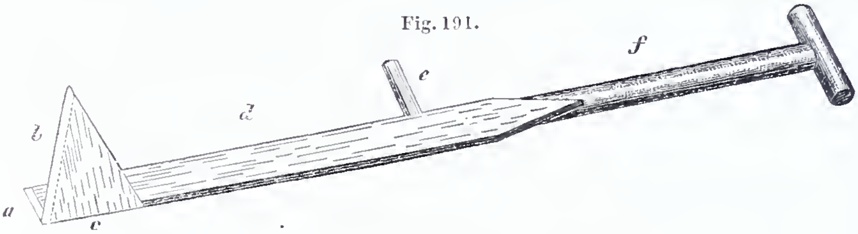


THE CLAY-LAND SHOULDER DRAIN.

(1055.) A somewhat analogous mode to this last of draining heavy clay land is with the *wedge* or *plug*. As this mode of draining requires a very peculiar form of tools, they will be described as required for use.

(1056.) The first remarkable implement used in this operation is the *bitting-iron*, represented by fig. 191, where *a* is the mouth, 1¾ inch wide; *b* the bit 6 inches in length; *c* the width of the bit 4½ inches. The bit is worked out of the body of the instrument, and laid with the best tempered steel; *e* is the tramp of the implement, placed 18 inches *d* from the mouth *a*; it would perhaps strengthen the power of the implement to have the tramp on the same side as the bit *c*; and *f* is the helve, which is of the length of that of a common spade.

Fig. 191.



THE BITTING-IRON IN PLUG-DRAINING.

(1057.) This species of draining is represented by those who have practised

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[*] Quarterly Journal of Agriculture, vol. vii., p. 246.

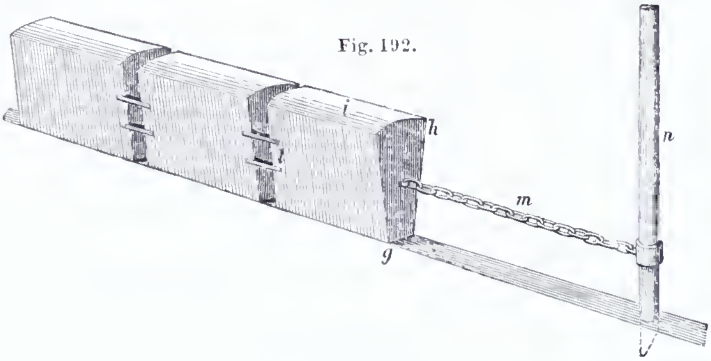
it to be applicable to all soils that have a various and uncertain depth of vegetable mould, incumbent on a subsoil of tenacious clay, exceedingly impervious to water, and never dry but by evaporation. It is, however, more suitable to pasture than to arable land, although it will suit all heavy soils that are far removed from stones, or where tiles cannot be conveniently made; but I would remark on this last observation, that I would advise you to prefer *tile* draining to this mode, even although the tiles be very dear, either from distance of carriage or difficulty of manufacture on the spot.

(1058.) The first process is to remove the surface turf, 12 inches in width, and 6½ inches in depth, with the common spade, and to place it on the right hand side of the workman, with the grass side uppermost. A cut is then made in the clay, on each side of the drain, with an edging iron, the circular-mouthed spade, as fig. 150, but a common spade will answer the purpose well enough, and it requires some skill and dexterity to remove this second cut properly. The first cut having been made with the spade 12 inches wide, the second should be made at such an angle down both sides of the drain, 9 inches deep, as that the breadth at the bottom shall be the exact width of the top of the plug *h*, fig. 192, that is, 4 inches wide. Carelessness in expert, or blundering in inexperienced workmen, in this part of the operation, has caused this kind of drain to fail. The bitting-iron then completes the cuttings, by taking out the last cut 9 inches deep, and 1¾ inch wide at the bottom. This instrument is used in this manner: The workman gives its shaft such an angle with the ground line that when pushed down to the requisite depth it continues the cut made by the spade or edging-iron used previously, on the right hand side of the drain; and he does exactly the same on the opposite side of the drain, using his foot in both cases on the tramp *e*, fig. 191. On being forced down on the second side of the drain, the clay that is now separated all round by the bit *b*, leans against the stem of the iron, and is easily lifted out, so that each bitful of the clay taken out by this instrument will have the form of an oblique parallelopepidon. If this part of the operation is performed inaccurately the drain cannot succeed; because the angle and depth made by this instrument are of the utmost consequence in forming the bed which is to be occupied by the plug. Considerable accuracy of hand and eye are requisite, which indeed cannot well be acquired by workmen without much experience, but both may be soon acquired. The clay from the two last cuttings should be placed on the left hand side of the workmen, or the opposite side to that on which the upper turf was laid; and from the last cutting being uppermost, it will come readily to hand when first returned into the drain. Any loose soil that may happen to remain at the bottom should be carefully taken out by a scoop spade, such as fig. 152, so as to leave the drain perfectly clean before the farther operations are effected.

(1059.) The next implement used is the *suter* or *plug*, fig. 192, which consists of three or more pieces of wood *i*, 8½ inches in height, 6 inches in length, 4 inches wide at the top *h*, and 1¾ inch wide at the bottom *g*, joined together by means of iron links *l* sunk into the sides which allow them to pass in a cut with a slight curve. A single suter of 18 or 24 inches long would answer the same or perhaps better purpose. These dimensions are the guage of the opening of the drain described above.

(1060.) The next step in the process is the placing of the plugs on their narrow edges in the bottom of the drain, which they will exactly fit, if the drains have been properly cut out. The most important part of the process is now to be done. The clay that was last taken out with the bitting-iron is well rammed down upon the plugs, the pieces of the clay being perfectly incorporated into one mass; then the next portion that was cut is returned, and equally well rammed down; and lastly, the turf is placed in the order it was taken out, and fixed in its original position. The whole earth and the turf are rammed down to the full length of the plug, with a rammer made for the purpose, or with such a one as is represented by fig. 175. The operation of ramming being finished, the lever *n*, fig. 192, is then struck into the bottom of the drain, and the plugs drawn forward to within 8 inches of their entire length by the power of the lever en the chain *m*, which is hooked to a staple in the end of the nearest plug. The work of ramming proceeds thus step by step until the whole drain is completed.

Fig. 192.

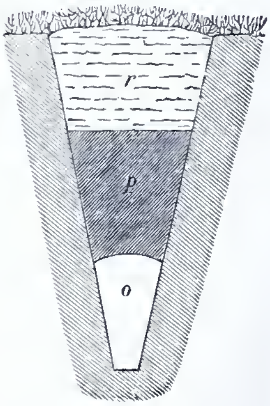


THE SUTERS OR PLUGS IN PLUG-DRAINING.

(1061.) The finished drain is represented in section in fig. 193, where *o* is the duct left in the clay by the plugs, 8½ inches high; *p* is the clay that was rammed down above the plugs, 9 inches deep; and *r* is the returned turf, with the grassy side uppermost, 6½ inches, which again makes the surface smooth, making a drain of 2 feet in depth. These two figures are drawn to the scale of ⅛ of an inch to 2 inches.

(1062.) Some particulars in the conducting of the work should be attended to. 1. Care should be taken to return *all* the earth that was cast out of the drain. This is a criterion of good work; and for this purpose, the ramming being the most laborious part of the operation, the workmen are apt to execute it in an inefficient manner, and should therefore be strictly superintended in its execution. Four men and a boy are the best number of people for carrying on the work expeditiously; and only stout people should be employed, as the ramming is really a laborious process. 2. As few main drains should be made as possible, and the open ends of all should be protected against the inroads of vermin; or what is a better finish, the lowest end of a plug drain should be furnished with tile and sole or stone. The main drains, of course, should be made larger than the ordinary drains, and they will have to be provided with proportionally larger plugs. The drains should be at a distance from each other, in proportion to the drawing nature of the subsoil. 3. No stock whatever should be allowed to enter the field

Fig. 193.



THE SECTION OF A PLUG DRAIN.

while under this treatment, and even not until the earth over the drains has again become somewhat firm. After the drains of a field are all finished, the ground should be rolled with a heavy roller. 4. This sort of drain should not be made in frosty, snowy, or very rainy weather, as the earth to be rammed in will then be either too hard, crumbly, or too soft. A strict superintendence of the work when it is going on is the only guarantee for efficiency of work; for as to the expedient of imposing fines upon poor workmen, they cannot be exacted without hardship, and perhaps injustice.

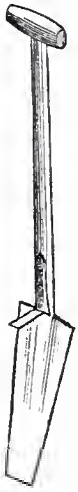
(1063.) Mr W. S. Evans, of Selkirk House, near Cheltenham, Gloucestershire, executed 300 miles of this kind of drain in 4 years, and is well pleased with its effects upon the land that has been subjected to it.

(1064.) It is not so inexpensive a mode of draining as it at first sight appears, costing 1¼d. the lineal yard, or L.5 : 0 : 10 the acre, according to Mr Evans' experience; but according to another account, the expense is 4d. the rood of 6 yards, or L.2 : 13 : 9¾ the acre.

(1065.) The principle of this mode of draining is said to have succeeded well on the tops of the Gloucestershire hills, where the bottoms of the drains descend to and are cut through rock, and where the bitting-iron and plug have been laid aside for the pick-axe, the channel formed by which is covered with flat stones; and the whole covered with clay rammed down as before described. *This* may be a permanent mode of draining; but in plug-draining in clay, I have no doubt that water will have the effect of softening the sides of the duct, and causing the rammed wedge of clay above to slip downwards; and should the water ever reach to the wedge, the latter will inevitably crumble down, and either entirely fill up, or form a dam across the duct.*

(1066.) An imperfect form of wedge-draining is practised in some parts of England on strong clay soils, under the name of *sod*-draining. It is executed by removing the upper turf with the common spade, and laying it aside, for the purpose of making it the wedge at a subsequent part of the operation; and if the turf is tough, so much the better for the durability of the sod-drain. Another spit is made with the narrow spade, fig. 170, and the last or undermost one is taken out with the narrowest spade represented in fig. 194, which is only 2½ inches wide at the mouth, and as its entire narrowness cannot allow a man's foot being used upon it in the usual manner, a stud or spur is placed in front at the bottom of the helve, upon which the workman's heel is pressed, and pushes down the spade and cuts out the spit. The depth may be to any desired extent. The upper turf is then put in and trampled or beaten down into the narrow drain, in which it becomes wedged against the small shoulder left on each side of the drain, before it can reach the narrow channel formed by the last-mentioned spade, fig. 194, and the channel below the turf being left open, constitutes the duct for the water. It will readily be perceived, that this is a temporary form of drain under any circumstances, though it may last some time in grass land, but it seems quite unsuited for arable ground, which is more liable to be affected by dashes of rain than grass land,

Fig. 194.



THE NARROWEST SPADE FOR SOD-DRAINS.

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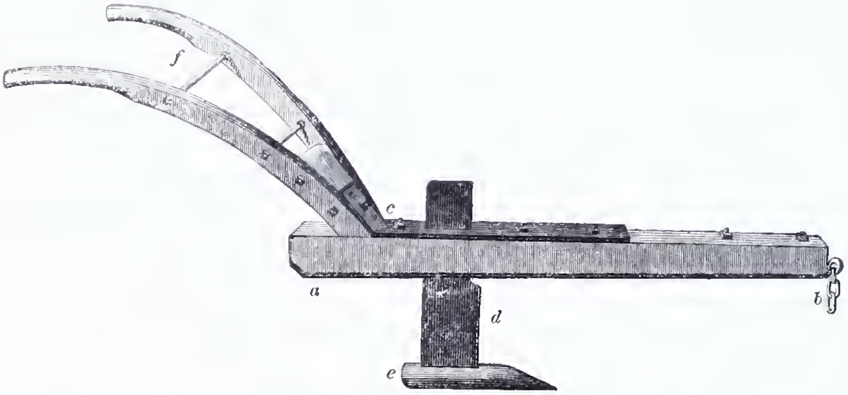
* Quarterly Journal of Agriculture, vol. iv. p. 501, and vol. xi. p. 68.

and in any situation the clay in contact with water will run the risk of being so much softened as to endanger the existence of the dust.

(1067.) Another method of draining is performed on strong clay land by the *mole plough*. This implement is almost unknown in Scotland, its use being confined to some parts of England, particularly in those parts where grass land on a clay subsoil abounds. It was, I believe, first introduced to the notice of Scottish agriculturists by the Duke of Hamilton, who caused it to be exhibited publicly on the occasion of the Highland and Agricultural Show at Glasgow in 1838. The day after the Show, I saw it exhibited in operation on a farm in the neighbourhood of Glasgow, of strong clay land, for it seems to be best suited to operate in that kind of soil. Its object is to make a small opening in the soil at a given distance from the surface, in the form of a mole-run, to act as a duct for the water that may find its way into it; hence its name of *mole* plough. It makes the pipe or opening in the soil by means of an iron-pointed cone, drawn through the soil by the application of a force, considerably greater than that applied to a common plough.

(1068.) The mole-plough as a draining machine can never be of much utility in a country like Scotland, whose alluvial formations, though not deficient in extent, are characterized more by the abundance of their stony matters than by their clays as occupying the place of subsoils; and it is only in the few patches of *carse-land* that such clays occur as can be brought under the action of the mole-plough. In all those subsoils where boulders occur, whether large or small, the mole-plough is so inapplicable, its usefulness is limited to such subsoils as consist of pure alluvial clays. In England, and where extensive flat districts of country occur, there the alluvium may be found which are the proper sphere of action for the mole-plough.

Fig. 195.



THE MOLE PLOUGH.

(1069.) This plough is of extremely simple construction, as will appear from fig. 195, which is a view of it in perspective. It consists of a beam of oak or ash wood 6½ feet in length, and measuring 6 by 5 inches from the butt-end forward to 4 inches square at the bridle *b*. As the beam when in operation lies close upon the ground, and is indeed the only means of regulating the depth at which the conduit is to be formed, the lower side is sheathed all over with a plate of iron about ½ inch thick. This plate at the proper place (4 feet 4 inches, or thereby, from the point of the beam) is perforated for the coulter-box; its fore-end is worked into an eye, which serves as a bridle, and is altogether strongly bolted to the beam. At the distance of a foot behind the coulter-box a strong stub of wood is mortised into the beam at *c*, standing at the rake and spread which is to be given to the handles. Another plate of iron, of about 3 feet in length and ½ inch thick, is applied on the upper side of the beam; the coulter-box is also formed through this plate, and the hind-part is kneed at *c*, to fit upon and support the stub, to which, as well as to the beam, the plate is firmly bolted. The two stilts or handles *c f* are simply bolted to the stub, which last is of such breadth as to admit of several bolt-holes, by which the *height* of the handles can be adjusted. That which may be termed the head of the plough is a malleable iron plate of about 2 feet in length; that part of it which passes through the beam, and is there fastened by means of wedges like the common coulter, is 7 inches broad and ¾ inch thick. The part *d* below the beam that performs the operation of a coulter, is 9 inches broad, ¾ inch thick in the back edge, and thinned off to a knife-edge in the front. The share or *mole*, is a solid of malleable iron, welded or riveted to the head; its length in the sole is about 15 inches, and in its cross section (which is a triangle with curved sides and considerably blunted on the angles) it measures about 3 inches broad at the sole, and 3½ inches in height. A cylinder is, however, a better form than a triangle; but in either case, the fore-part of the share is worked into a conical form, the apex being in the line of the sole, or nearly so. This, while it enables the share to penetrate the earth more freely, prevents a tendency to rising out of the ground. The tendency to rise is, however, not so great as may be supposed, for the centre of motion in this implement being very low, not less than 12 inches under the surface of the ground, and the draft being applied horizontally, there is a strong tendency in the point of the beam and of the share, as in all similar cases of oblique draft, to sink into the ground, (804.)–(808.); the effect of which, if not properly balanced by the effects of *form* in the parts, will give the mole-plough much unnecessary resistance.

(1070.) In working this plough, the draft-chain is attached to the bridle-eye at *b*, and it is usually drawn by two horses walking in a circular course, giving motion to a portable horse capstan, that is constructed on a small platform movable on low carriage-wheels, and which is moored by anchors at convenient reaches of 50 to 60 yards. The mechanical advantage yielded by the horse capstan gives out a power of about 10 to 1, or, deducting friction, equal to a force of about 14 horses.

(1071.) When the plough is entered into the soil and moved forward, the broad coulter cuts the soil with its sharp edge, and the sock makes its way through the clay subsoil by compressing it on all sides, and the tenacity of the clay keeps not only the pipe thus formed open, but the slit which is made by the broad coulter permits the water that is in the soil to find its way directly into the pipe. The plough is found to work with the greatest steadiness at 15 inches below the surface. The upper turf is sometimes laid over beforehand by the common plough, when the mole plough is made to pass along the bottom of its furrow, and the furrow-slice or turf is again carefully replaced. This is the preferable mode of working this plough, as it serves to preserve the slit made by the coulter longer open than when it terminates at the surface of the turf, where, of course, it is liable to be soon closed up; but the least trouble is incurred when the plough is made to pass through the turf unploughed.

(1072.) To work the whole apparatus efficiently 2 horses and 3 men are required; and if the common estimate of 10s. a-day for 2 horses and 1 man is taken, but which is too high, as you shall have occasion afterwards to learn, and 3s. 6d. for the other 2 men, an acre of ground can be mole-drained for 13s. 6d. exclusive of the first cost and tear and wear of this apparatus, the cost of which cannot be less than L.50. At this rate, this is the cheapest of all the modes of draining that you have yet heard of.

(1073.) If the mole plough is put in motion in soft clay, the slit made by the broad coulter will not remain open even for a single day; and though it may again open in severe drought, it will close again whenever the clay becomes moist. This plough seems fitted for action only in pure clay subsoils, and when such are found under old grass, it may partially drain the ground with comparative economy; and the process being really economical, it may be repeated in the course of years in the same ground. In my estimation, this mode of draining cannot bear a comparison for efficacy to tile-draining, although it is employed in some parts of England, where its effects are highly spoken of.*

(1074.) It has lately been proposed by Mr Scot of Craigmoy, Stewartry of Kirkcudbright, to substitute tubes of larch wood for drain-tiles, in situations where larch is plentiful, and consequently cheap, and drain-tiles dear, and he considers that they would be equally efficient with tiles in many situations, and especially in mossy soils. Were larch tubes confined to draining mossy soils, I conceive they would answer the purpose well, not only on account of their length maintaining their original position in the drain; but on account of the durable nature of larch where water is constantly present, as is instanced in cases of great antiquity, such as the piles of larch upon which the city of Venice is founded. The larch tree that is felled in winter, and allowed to dry with the bark on, is much more durable and useful for every purpose, and infinitely more free of splits and cracks than that which is cut down in sap, and immediately deprived of its bark for tan.

Fig. 196.

THE LARCH DRAIN-TUBE.

(1075.) The tube finished, fig. 196, presents a square of 4 inches outside, with a clear water-way of 2 inches. To those who wish to know how they are made I refer to Mr Scot's published statement;† but in doing this I must remark that the cost of these tubes will exceed that of clay tiles. For, take the cost of drain tiles at 30s. per 1000 including carriage, that will be 1½ farthing the lineal foot. Now, a lineal foot of larch tube contains say 1 superficial foot of timber at 1 inch thick, which will cost for carriage and sawing the timber 1 farthing; the fitting, boring, and pins will cost other 2 farthings; and the timber, at 6d. the cubic foot, will increase the cost 2 farthings more, which altogether make the tube more than 3 times dearer than tiles; and if the cost of the timber is thrown into the bargain, still they will be double the price of tiles.

(1076.) The recommendation of wooden tubes for the purpose of draining land, reminds me of many expedients which are practised to fill drains, among which are brushwood, thorns, trees, and even straw-ropes. With the exception of the trunks of small trees, which, when judiciously laid down in drains, may last a considerable time, it is not to be imagined that brushwood of any kind can be durable. Hence drains filled with them soon fall in. It could only be dire necessity that would induce any man to fill drains with straw twisted into ropes; and it could only have been the same cause, in situations where stones were scarce, and at a time when drain-tiles were little known in Scotland, such as was the case during the late war, that could have tempted farmers to fill drains with thorns. No doubt, the astringent nature of thorn wood and bark may preserve their substance from decay under ground for a considerable time, but the sinking of holes in such drains, as I have seen, were infallible symptoms of decay. Only conceive what a mess such a drain must be that is "filled up to the height of 8 or 10 inches either with brushwood, stripped of the leaves—oak, ash, or willow twigs being the best—and covered with long wheat straw, twisted into bands, which are put in with the hand, and afterwards forced down with the spade, care being taken," the only case of it evinced in the whole operation, "that none of the loose mould is allowed to go along with them. The trench is then entirely filled up with earth, the first layer of which is closely trampled down, and the remainder thrown in loosely."* And yet such is the practice in several of the south-eastern and midland counties of England.

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* See the Agricultural Surveys of Middlesex and Essex.

† Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 99-109, where the machinery for making these tubes is figured and minutely described.

(1077.) Of the *durability of common brick* when used in drains, there is a remarkable instance mentioned by Mr George Guthrie, factor to the Earl of Stair, on Culhorn, Wigtonshire. In the execution of modern draining on that estate, some brick-drains, on being intersected, emitted water very freely. According to documents which refer to these drains, it appears that they had been formed by the celebrated Marshal, Earl Stair, *upwards of a hundred years ago*. They were found between the vegetable mould and the clay upon which it rested, between the "wet and the dry," as the country phrase has it, and about 31 inches below the surface. They presented two forms; one consisting of 2 bricks set asunder on edge, and the other 2 laid lengthways across them, leaving between them an opening of 4 inches square for water, but having no soles. The bricks had not sunk in the least through the sandy clay bottom upon which they rested, as they were 3 inches broad. The other form was of 2 bricks laid side by side, as a sole, with 2 others built on bed on each other at both sides, upon the solid ground, and covered with flat stones, the building being packed on each side of the drain with broken bricks.†

(1078.) Various attempts have been made to *lessen the cost of cutting drains*. One of these is to cut the drains narrower than they used to be, for the obvious reason, that the drawing power of drains lies more in their depth than breadth; and the cubical contents of drains, of any given length, have in consequence been much decreased, and the cost of digging them of course much lessened.

(1079.) An attempt has been made with this view by Mr Peter M'Ewan, Blackdub, Stirlingshire. His invention consists of the application of the plough in casting out the contents of drains, and it certainly displays much mechanical ingenuity, and really performs the work with a considerable degree of perfection. This application of the plough, however, is by no means adapted to every species of subsoil, the most common one, of a tilly clay, containing small stones and occasional boulders, presenting insuperable difficulties to its progress, whilst in pure unctuous clay it cuts its way with ease, and lays aside the tenacious furrow-slice with a considerable degree of regularity. The instrument has thus a limited application, but a greater objection exists against it, inasmuch as it requires an inordinate amount of power to set it in motion, consisting of that of 12 horses. This circumstance alone still more limits its application, for there are comparatively few farms which employ 6 pairs of horses at work; and besides, it is almost impossible to yoke 12 horses together, so as to derive the amount of labour from them, as when yoked in pairs. It is truly distressing to see the horses working with this plough, as I once had the opportunity of witnessing in a field, of favourable subsoil too, in the neighbourhood of Glasgow in 1838, on the occasion of the Highland and Agricultural Society's Show.

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* British Husbandry. vol. i. p. 457.

† Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 45.

(1080.) Mr Smith, Deanston, has given a description of Mr M'Ewan's draining plough, which it is not necessary to particularise farther than that the horses go in two divisions, one on each side of the line of draught, yoked to a strong master-tree 10 feet long, arranged so as to have 4 abreast, when 8 horses are used, and 6 abreast when 12 horses are yoked.

(1081.) With regard to the state of the work left by this plough, men follow with spades, and take out a bed for tiles or broken stones, and correct any deviation from a uniform fall in the bottom, occasioned by unevenness of ground. The tiles or stones are then put in in the usual manner, and the earth is returned into the drain by the plough.

(1082.) This drain-plough is made of two sizes, one weighing 5 cwt., costing L.11, the other weighing 4 cwt., and costing L.8, 8s., and the bars or swingle-trees, necessary to accompany each plough, are 2 six-horse, 4 three-horse, and a strong chain, the whole costing L.4, 4s.

(1083.) With regard to the length of drain cut by this plough, Mr Smith estimates the time spent at 2 miles per hour for 8 hours; and allowing $\frac{1}{3}$ of it to be lost in turnings, the actual quantity of work done in 8 hours he takes at 3126 roods of 6 yards, or about $19\frac{1}{2}$ acres, at 15 feet asunder, the drains being cut from 18 to 22 inches in depth. This quantity of work is corroborated by Mr John Glen, Hilton, Clackmannanshire, who states that "we drain 400 Scotch chains in 9 hours," going down hill with the furrow, and up empty.

(1084.) The rate of walking taken by Mr Smith, at 2 miles the hour, is too great, as the distance travelled in ploughing 1 imperial acre of ground, in the usual way, in a day of 10 hours, which constitutes a good rate of work, is $9\frac{7}{8}$ miles, or only 1742 yards per hour, including of course turnings. There is also a discrepancy in Mr Glen's statement of draining nearly half the extent of his land in 9 hours, going half the time empty, with another statement where he says, "we have used Mr M'Ewan's drain-plough for the last 4 months, and have drained 837 chains, Scotch measure, with it;" that is, only 2 days' work in 4 months, with 6 horses, the drain being $18\frac{1}{2}$ inches wide at top and 8 inches wide at bottom, and from 15 to 17 inches in depth.

(1085.) The cost of employing this drain-plough is thus given by Mr Smith:

12 horses at 4s. a-day each, ...	L.2	8	0
8 men at 2s. a-day each, ...	0	16	0
To cover interest of cost, and tear and wear of plough, say 1s. the hour, ...	0	8	0
	L.3	12	0

which is only $1\frac{1}{3}$ farthing per rood of 6 yards.*

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* Smith's Remarks on Thorough-Draining, pp. 26-31.

(1086.) Other ploughs have been invented for making drains, which have attracted attention, and engaged the advocacy of friends in the immediate locality in which they originated, but seem never to have extended farther.

(1087.) In 1832, Mr Robert Green, a farmer in Cambridgeshire, published an account of a drain-plough of his invention. It cuts the ground 23 inches deep and 8 inches wide at top, and 2 inches at bottom, at three cuts; the first being 9 inches, the second 8 inches, and the third 6 inches deep. It is said to take the earth out clean, leaving none to shovel out. It cuts about 500 or 600 poles or rods of the above dimensions, at three times. It requires 4 horses the first time, and 6 horses the other two, and 2 men and a boy to work them, at L.1, 10s. a-day. The price of this plough is quoted at L.15.*

(1088). In 1833, Mr Thomas Law Hodges published an account of a drain-plough invented by Mr John Pearson, Frotterden, near Cranbrook in Kent. The drain is taken out by it at three turns. Men follow with narrow scoops, and throw out all the loose earth clean, which finishes the drain at 26 inches deep, at an expense of 1d. the rod.

(1089.) Both these implements are best adapted to strong clay subsoils, and best for plug-draining, especially Pearson's, when, after its operation, a long narrow plug or slide of wood is used, the clay being rammed down upon which, it is then drawn forward by means of a windlass and rope. This plough is estimated to cost L.9, 5s., but with spades, scoops, and rammers, it costs L.18.†

(1090.) I am now arrived at a very important question connected with the draining of land, namely, Whether *landlords should undertake part of the expense?* This question cannot be satisfactorily answered without taking into consideration the object and effect of draining land, and the cost attending it. The object of draining land is simply to make it dry, but in doing that, the fertility of the soil is found to be increased, not merely for a year or two, or even for a rotation of crops, which manure only affects to embrace, but *at least* for the duration of a 19 years' lease, and probably for a much longer period, and possibly for an indefinite length of time. Here, then, is an operation which is capable of making land better, not merely in a temporary, but in a permanent manner, and hence its intrinsic worth is to increase the permanent value of land. This being the case, the question simply resolves itself into this: Ought landlords to allow other parties to enhance the permanent value of their land, or, permitting it, ought they to accept a permanent increase of rent for land whose permanent value they have in no way contributed to enhance? Can they in honour refuse to assist in the permanent improvement of their land, and yet exact the highest rent the land is worth, in consequence of those improvements? I think, in honour, they cannot act thus; it would be unfair to do so. Improvement effected by judicious draining is acknowledged to be permanent, that effected by good husbandry is acknowledged to be temporary. In the latter case, the landlord is quite entitled to derive every additional advantage arising from good management, because it is in the power of the tenant, if he chooses, to avail himself of all its good effects during his lease, and if he leave any remarkable advantage to his landlord, it is the act of his own free will; but in the permanent improvement of draining, he cannot avail himself of its entire advantages. Some of these, and indeed the whole value of these advantages may be given over to the landlord at the end of the lease; and this being practically the case, the landlord in fairness should not accept of an improvement in his condition effected by a process to which he has in no degree contributed. To enable him to accept such an effect with honour, he should insist on becoming a party in the process of acquiring it along with his tenant. This is the question regarding draining in reference to the landlord, but there is one also in connection with the tenant, namely, ought he to spend his money in draining his landlords' land without assistance? In fairness to himself, he ought not to do so; and, at any rate, it is improper in him to do it without, in the first instance, obtaining his landlord's consent. Nevertheless, in regard to both questions, there are landlords who refuse to drain, and there are tenants who do drain, farms, at their own risk, the tenants thereby gratuitously, as it were, creating an increase of income to their landlords, without receiving an equivalent in return. When the subject of draining is placed only in this light before the tenant, the chief and indeed only consideration with him is, whether the outlay he will incur by it will be returned to him during the currency of his lease? and if the trouble and cost he will be at will no more than accomplish this, his condition will remain unimproved; for, to improve his condition, he would require to receive a larger return than the mere amount of the money he expends. I believe most of the draining executed in this country of late years has been conducted by the tenant in the hope that he will have his outlay returned to him before the expiry of his lease. But this is an unsatisfactory state for a tenant to be placed in, because it secures neither the permanent improvement of the soil, nor insures the co-operation of its owner, whilst it diverts a large proportion of the capital of the tenant into a channel from which there may possibly flow no advantage to him; because, though there is, in every case, little doubt of the land deriving benefit from draining, there is a well-grounded apprehension whether the tenant will have time to receive back all the money he expends, and whether at the same time he will be remunerated for the trouble of conducting the operation, for which he is entitled to be so as much as any other man who is engaged in business. This apprehension is strengthened from the circumstance that a large sum is required to drain land in an efficient manner; that from L.3 to L.10 an acre are required to do it; can the tenant therefore with prudence solely undertake so expensive a system of improvement, since it is clear that the landlord will derive advantage from it, whether he participate in the outlay or not. This being the state of things, the landlord has no direct motive in offering to participate in the expense; but the tenant has a direct one for requesting him to do it. It is, therefore, not improbable, that where the landlord does not assist his tenant in draining, the fault rests with the tenant in neglecting to request his co-operation; for in the circumstances, it would require a landlord to be actuated by a very high sense of honour and justice, before he would voluntarily offer to participate in an expense, the benefits accruing from which he will enjoy as much without the outlay. It is feared that in such circumstances the inevitable consequence should be, that the assistance of the landlord must be requested, or the tenant undertake the whole outlay himself.

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* Green on Underdraining Wet and Cold Land.

† Hodges on the Use and Advantages of Pearson's Draining-Plough.

(1091.) I have hitherto conducted this argument on the supposition of landlords refusing to incur any part of the expense of draining land; but were they to undertake, as a matter of course, the proportion which really belongs to them in the relation in which they stand with their tenants, the inconvenience to the tenants of having to disburse a large sum of money would be avoided, and they would then require to possess no larger capitals than what would fully stock their farms, and all the operations connected with draining would be executed in the most substantial manner. Landlords would then be fairly entitled to receive the full increase of value which would be derived from draining. As the true relation of the landlord and tenant in regard to draining has hitherto not been so clearly illustrated as it deserves, I shall endeavour to shew the proper positions of both parties, by proving that it is more a landlord's than a tenant's question, even in tho low view of pecuniary remuneration, which is probably the most practical way of viewing the subject; and in doing this I shall first consider the opinions of some practical men who have expressed their sentiments on this interesting inquiry.

(1092.) Mr Roberton, Ladyrig, who has drained much, and considered the relation of landlord and tenant in regard to the prosecution of that operation, expresses himself on the subject in judicious terms. While commenting on the different style of draining which is executed by the tenant himself, from that which is undertaken conjointly with the landlord, he says, "that the immediate effect in both cases is much the same; and to serve merely the temporary purpose of the tenant, I have no doubt that the one will prove as beneficial as the other. To the proprietor, however, the case is very different; because, by the latter method, an improvement is effected which may be guaranteed to endure for several leases. It is very doubtful whether, by the former mode, it can be ensured much beyond the existing lease. That the proprietor should at all times become a party, and thereby secure the permanent improvement of his estate, is now very generally admitted; and yet the plan is not always acted upon. It may, however, be asserted, without much fear of contradiction, that improvements by thorough-draining will never become general, or be mado permanent, unless the assistance of the landlord be obtained. When left altogether to the tenant, want of capital and the shortness of the lease will tend at all times to limit the extent of improvements, and will seldom be made permanent; because the true interest of the tenant is to execute the work only in such a manner as will secure his own temporary purpose. To the proprietor, among the many inducements to improve his estate by draining, the greatest, at least the most satisfactory, is, that it yields an immediate and large return. If he has no spare money, he has only to borrow it at 4 per cent. and lend it out at 6 per cent.; a per centage which no tenant will refuse to pay, and upon a security, too, undoubted—that of his own property. No one will deny that a proprietor is as justly entitled to receive a fair return for money laid out in the improvement of his estate, as he is for that laid out on the original purchase of it. Hence, I would assume, as a general principle, that for every penny laid out by a proprietor upon ameliorations of any kind, he shall have an assurance of a return, either immediate or prospective—immediate, in the form of interest or of additional rent; prospective, in the increased value of his property, by which, in after leases, it will yield such an increase of rent as will repay the present outlay. Again, as regards a tenant, I will assume that he will make every improvement the subject of a calculation of profit or loss for *one lease only*, and that he will not lay out any money *merely for the purpose* of making improvements to extend beyond that period. Let him even have an assurance of a renewal of his lease, still, before that takes place, a valuation will be made of his farm, and in that valuation will be included his improvements; so that, while he originally disbursed the whole expense of them, he will in reality have to pay for them again in the shape of additional rent."

(1093.) In the instances of the cost of draining given a few pages back, that incurred by Mr Roberton varied from L.4 : 17 : 6 to L.3 : 8 : 4 the acre. In the first example, Mr Roberton informs us that the proprietors of his farm, the Governors of the Merchant Maiden Hospital in Edinburgh, bore the expense of opening the drain, and the work was executed in a manner that, he conceives, will render them of permanent service to the land. In the other case, they were wholly executed at his own expense, upon a lease of only 12 years' duration, and were therefore more superficially executed. "In the preceding examples," he proceeds to say, "both methods have been tried, and both have succeeded. And I think they tend to prove, in the first place, that the difference in the expense of the two methods is very nearly equal to what may be deemed a fair allowance for the landlord; and when it is taken into consideration that, by the cheaper mode, the improvement of a greater extent of land is completed in a given time without materially increasing the number of horses upon the farm, it is doubtful whether, in the end, it may not prove the more profitable one for the tenant; and, in the second place, it proves that, to a tenant of capital, the assistance of the landlord is by no means so essential a matter as to deter him from engaging in an improvement of the kind. For, as a mere speculation, he may embark in it with confidence; and let the prices of produce vary as they may, the money expended in this way will always yield him a fair return."*

(1094.) In a table of the relative proportion which landlords and tenants should bear in the making of drains, Mr Smith, Deanston, has taken that of $\frac{2}{3}$ for the landlord and $\frac{1}{3}$ for the tenant,—being the reverse of what Mr Roberton's remarks seem to indicate.

Cost of draining the acre,			Landlord's share.			Tenant's share.		
L.	S.	D.	L.	S.	D.	L.	S.	D.
9	10	0	6	6	8	3	3	4
8	12	7	5	15	0	2	17	6
7	18	9	5	5	10	2	12	11
7	6	3	4	17	6	2	8	9
6	16	3	4	10	10	2	5	5
6	6	7	4	4	5	2	2	2
6	0	0	4	0	0	2	0	0
5	12	6	3	15	0	1	17	6
5	6	3	3	10	10	1	15	5
5	0	0	3	6	8	1	13	4
4	15	0	3	3	4	1	11	8
4	10	0	3	0	0	1	10	0
4	6	3	2	17	6	1	8	9
4	2	6	2	15	0	1	7	6
4	0	0	2	13	4	1	6	8
3	16	3	2	10	10	1	5	5
3	12	2	2	8	4	1	4	6
3	10	0	2	6	8	1	3	4
3	7	6	2	5	0	1	2	6
3	4	0	2	3	4	1	1	5
3	2	6	2	1	8	1	0	10
3	1	3	2	0	10	1	0	5
3	0	0	2	0	0	1	0	0
2	17	6	1	18	4	0	19	2
2	16	3	1	17	6	0	18	9
2	15	0	1	16	8	0	18	4
2	13	9	1	15	10	0	17	11
2	11	3	1	14	2	0	17	1
2	10	0	1	13	4	0	16	8
2	8	6	1	12	6	0	16	3
2	7	9	1	11	8	0	15	10†

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* Prize Essays of the Highland and Agricultural Society, vol. xiv. p. 43-5.

Smith's Remarks on Thorough-Draining, p. 16.

(1095.) The statement of Mr George Bell, Woodhouselees, of the cost of tile-draining (1028.), shews the actual proportions borne by his landlord the Duke of Buccleuch and by himself, in the draining of his farm. The proportions are relatively these :—

By the landlord—

38,000 3-inch tile, at 25s.	L.47 10 0	
1,577 4-inch ... 32s.	2 10 5	
Cutting 2003 roods of 6 yards, at 3d. the rood, ...	26 0 9	
Slates for soles, ...	1 5 0	
Total cost by the landlord,	L.77 6 2	or, per acre, L.5 18 11

By the tenant—

Leading 38,000 3-inch tiles, at 3s. 4d. per 1000, ...	L.6 6 8		
Leading 1577 4-inch tiles, at 5s. the 1000, ...	0 7 10		
31 days' work of man and horse laying down tiles, straw for covering them, &c. at 5s. 6d. per day, ...	8 10 6		
Women loading and unloading carts, ...	2 3 0		
31 days of a man setting tiles,	2 5 0		
31 days of a woman assisting him, ...	1 0 0		
3 days of a plough, and horses and man, ...	1 10 0		
		L.22 3 0	or, per acre, L.1 14 1
Total cost by landlord and tenant,		L.99 9 2	
Total cost per acre, ...			L.7 13 0

Taking Mr Smith's proportion of $\frac{2}{3}$ for the landlord, the ratio which the Duke of Buccleuch should pay of the total cost of L.99 : 9 : 2 should be L.66 : 6 : 1$\frac{1}{4}$; but he actually paid L.77 : 6 : 2, being more than $\frac{3}{4}$, that being L.74 : 11 : 0$\frac{1}{2}$, and nearly $\frac{4}{5}$, which is L.79 : 11 : 4.

(1096.) In every case, the landlord should, as I think, follow the above example, and disburse the expense of cutting the drains and the cost of the materials for filling them, though these should be brought from a distance, or inaccessible without much labour. The tenant should afford carriage of all sorts, and pay, besides, the legal rate of interest, on the landlord's entire outlay. On these conditions, with the expense, mutually borne, of an experienced man to superintend the execution of the drains, according to specifications previously agreed on betwixt landlord and tenant, the drains will be executed in so efficient a manner as to last for an indefinite period of years. It may be seen, from this statement of Mr Bell, that, in fulfilment of these conditions, the landlord should incur $\frac{4}{5}$ and the tenant only $\frac{1}{5}$ of the expenses, proportions which differ very materially in favour of the tenant from those laid down by Mr Smith, and still more so than those experienced by Mr Roberton. It appears, therefore, that on fixed rule has yet been established on this subject ; though it is desirable that there should be, and let us endeavour to discover a rule that shall deserve to be established.

(1097.) Suppose, then, that a landlord determines on thorough-draining a farm, and that for the purpose he takes the farm into his own hands, and disburses every cost, including carriages, attending the operation. When his purpose has been attained, and he wishes to let it in a drained state, it is no more than reasonable of him to desire to receive back his disbursements, principal and interest, during the currency of the 19 years' lease which he is about to enter into with a tenant; because, on the one hand, if the land will not repay the expense of its improvement in a reasonable time, and surely 19 years is a long enough time in which it should be repaid, there will be no advantage to either party in the improving of it, and, on the other hand, if a tenant receive an improved farm, he cannot expect to hire it on the same terms as when it was unimproved. Now, that a landlord may receive back all his disbursements, principal and interest, during a 19 years' lease, he would require to receive from the tenant 8 per cent. on them.

(1098.) Suppose, on the other hand, that the tenant disbursed every expense of draining, then, of course, it is equally reasonable that he should receive 8 per cent. on his outlay during the lease, in order to receive the entire sum back.

(1099.) But the positions of the two parties, landlord and tenant, in regard to expending the same amount in draining a farm, are widely different. The tenant is entitled to receive back not only all the money he has laid out, that is, to receive 8 per cent., but he is also entitled to receive at least 10 if not 15 per cent. more for his personal trouble in undertaking the task of draining another man's land, and for the risk incurred in laying out money on an undertaking attended with contingencies; because, in similar circumstances, commercial people expect 15 per cent. Thus the tenant, being a temporary lessee, should receive *at least* 18 per cent. for his disbursements, whereas the landlord, being a permanent owner, should be satisfied with *at most* 8 per cent. for the same amount of outlay. For in regard to the tenant, the period of his agreement, namely, 19 or any other number of years, is the longest period that he can calculate upon to receive back the money, and it is no matter though the lease should then be renewed, because the new conditions will be made as if the sitting tenant were a stranger; and on this account matters should be finally settled between him and his landlord at the end of the lease, which can only be accomplished by the tenant receiving from the farm 18 per cent. on his outlay; but in the relation of the landowner to his land, whatever improvement he effects upon it produces results to him to an indefinite period of time, and this being the case, all that he can expect in return for his outlay is the common rate of interest which he would receive were he to invest his money in any other ordinary security, and which, in such a case, never exceeds 5 per cent.

(1100.) Thus then when a tenant drains his farm thoroughly, he should receive at least 18 per cent. for his outlay, and when a landlord does it he should only receive 5 per cent. Now, what conclusion should be drawn from these premises? Clearly that the landlord should undertake the entire expense of draining his land; because his interest in the improvement is permanent, he has the strongest motives for improving it—his demands upon the land are moderate, amounting only to the usual rate of interest—and in his disbursing a portion of his capital a smaller portion of the capital of the country is placed in less jeopardy than when the tenant undertakes to fulfil the landlords' obligations.

(1101.) In both these suppositions the landlord and tenant are each supposed to have effected the entire drainage, but when a mutual understanding exists betwixt them on the subject, its condition would justly be based on the principles advocated in (1096.), and as the understanding betwixt the parties is only for a definite period, both parties expect and should receive, during that period, their respective amounts of interest or return on the outlay which each has incurred, namely, the landlord 8 per cent. and the tenant 18 per cent; and to attain this desirable end the tenant should not grudge his landlord his interest of 8 per cent., nor should the landlord exact a greater rent than what will enable the farm to pay the tenant 18 per cent. on his portion of the outlay, and either will not amount to a large annual sum. For example, suppose that $\frac{4}{5}$ or L.80 out of every L.100 are expended by the landlord, he should receive L.6, 8s. a-year to get his 8 per cent., and to give the tenant 18 per cent. on his $\frac{1}{5}$ or L.20 he would require to receive L.3 : 11 : 8 a-year, both sums making together 10 per cent. on the whole outlay, which, if exacted in the shape of an annual tribute from the land, would amount only to 4s. per acre on land worth 40s.,—a sum which thorough-draining would easily repay.

(1102.) [The mechanical principles of draining have been already so fully discussed that I need not detain you a moment with their examination: but this will be the best place for considering a most interesting subject connected with soil, upon which the whole *necessity* of draining depends, I refer to the manner in which an excess of water proves injurious to the fertility of the soil.

(1103.) In considering this subject it will be advisable to examine into the effects of water, 1*st* upon the mechanical condition of the soil, and 2*d*, upon its chemical constituents, reserving the influence which it exerts directly upon vegetation to be discussed on some future occasion.

(1104.) If you call to mind what I have said regarding the mechanical constitution of soil (516.), you will at once perceive that a soil *in situ* might not inaptly be compared to a porous solid permeated by innumerable tortuous channels, these channels being formed by the interstitial spaces occurring between the various particles composing the soil.

(1105.) If water is added gradually to soil, the first effect will be doubtless to fill these channels, but from the attraction which the various components of soil have for water, they speedily draw it into their pores, and thus empty the channels so that even after a considerable addition, the soil, *taken as a whole*, does not lose its porosity although each particle *has its individual pores* filled with water. This is the healthy condition of soil, it is what I shall call *moist*, in contradistinction to *wet*. Soil in this state can be crumbled down in the hands without making them muddy, although it feels distinctly *damp*, and will lose, when heated to 212° F., from 20 to 50 per cent. of water.

(1106.) If now more water should be added, the channels will be again filled, and as the pores of each particle are already saturated with moisture, they can again be emptied only by one of the two following methods: 1*st*, either very gradually by evaporation from the surface, as in *undrained soil*, or 2*d*, much more rapidly and effectually by the channels having communication with some larger channel in a relatively lower level, as is the case in *drained soil*. Soil in which all the interstices between its particles are more or less filled with water may be called *wet* soil, and all such land must be drained before it can be properly and advantageously cultivated.

(1107.) You will thus perceive that water does no harm, in fact it is absolutely necessary in soil so long as it does not alter its mechanical condition; but whenever it fills up the interstitial channels it becomes injurious for the following reasons:—1*st*, it prevents the circulation of air through the soil, as this takes place entirely through the medium of these channels,—2*d*, it impoverishes the soil by permitting soluble matter to soak through; because until these channels are filled there is no flow of liquid in the soil, except a very gentle current from below upwards, produced by capillary attraction towards the drier particles near the surface.*

(1108.) Again, an excess of water acts most injuriously in soil by reducing its temperature. This is owing to the extremely slight conducting power of water for heat; as compared to earthy matter, assisted also by the cold produced by continued evaporation. According to some experiments which I performed,—the diminution of heat produced in this way amounts, in summer, on an average to 6½ degrees of Fahrenheit, which, according to Sir John Leslie's mode of calculating elevation by the mean temperature, is equivalent to a difference of 1950 feet. When we consider the effects of elevation upon the nature and amount of produce, we shall have good reason to see the baneful effects of such a change as this represents.

(1109.) Besides the above injuries inflicted by an excess of water, there are numerous effects upon the chemical changes in the soil, and also upon the plants themselves, all of which must be considered in their proper place. I trust, however, that what I have advanced will serve to impress sufficiently on your minds the evident necessity of thorough-draining in all situations where the soil is *wet*.—H. R. M.]

(1110.) After pointing out the effects of draining in ameliorating the soil and promoting a healthy condition of vegetation, Professor Johnston proceeds to shew the effects of water upon clay soil. "I shall add one important remark," he says, "which will readily suggest itself to the geologist who has studied the action of air and water on the various clay beds that occur here and there as members of the series of stratified rocks. There are *no clays* which do *not* gradually *soften* under the united influence of air and of running water. *It is false economy, therefore, to lay down tiles without soles, however hard and stiff the clay subsoil may appear to be.* In the course of 10 or 15 years, the stiffest clays will soften, so as to allow the tile to sink, and many very much sooner. The passage for the water is thus gradually removed; and when the tile has sunk a couple of inches, the whole must be taken up. Thousands of miles of drains have been thus laid down, both in the low country of Scotland and in the southern counties of England, which have now become nearly useless; and yet the system still goes on. It would appear even as if the farmers and proprietors of each district, unwilling to believe in or to be benefited by the experience of others, were determined to prove the matter in their own case also, before they will consent to adopt that surer system which, though demanding a slightly greater outlay at first, will return upon the drainer with no after-calls for either time or capital. If my reader," continues the Professor, "lives in a district where this practice is now exploded, and if he be inclined to doubt if other counties be farther behind the advance of knowledge than his own, I would invite him to spend a week in crossing the county of Durham, where he may find opportunities not only of satisfying his own doubts, but of scattering here and there a few words of useful advice among the more intelligent of our practical farmers."*

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* See Prize Essay on this subject by me in the Prize Essays of the Highland and Agricultural Society, vol. xiii. p. 141.

† Ibid., vol. xiv. p. 227.

(1111.) As the preservation of the fall in a drain on nearly level ground is of great importance in drying it, it may be satisfactory to have a demonstration of the fact that the angle subtended by the plumb-line *d f*, in fig. 183, is equal to the angle of inclination of the drain *b a c*. The rule is, as radius : *a b* :: sine of the angle, *b a c* : *b c*, the height of the fall : Or, multiply the natural sine of the angle *b a c* by the length of the fall *a b*, and the same result will be obtained.†

(1112.) The Romans practised draining both with open and covered drains, the former in clay and the latter in porous soils. The instructions given by Palladius for the formation of drains may be received with surprise by modern practisers of the art on account of their correctness, and when their great antiquity is held in remembrance. "If the land is wet," he says, "it may be dried by drains drawn from every part. Open drains are well known; covered drains are made in this manner: Ditches are made across the field 3 feet deep; afterwards they are filled half-way up with small stones or gravel, and then filled to the surface with the earth that was thrown out. These covered drains are let to an open one to which they descend, so that the water is carried off, and destroys no part of the field. If stones cannot be got, branches, or straw, or any kind of twigs, may be used in their place."‡

28. OF YOKING AND HARNESSING THE PLOUGH, AND OF SWING-TREES.

"No wheels support the diving pointed share;
No groaning ox is doomed to labour there;
No helpmates teach the docile steed his road;
Alike unknown the plough-boy and the goad;
But, unassisted through each toilsome day,
With smiling brow, the ploughman cleaves his way."
BLOOMFIELD.

(1113.) Having inspected the varieties of soil within the sphere of your observation, and been told of the various modes in which the land may be stirred by the plough in winter, it will be proper for you to know the simple and efficient method by which horses are attached to and driven in the plough in Scotland, before the winter-ploughing of the soil is begun, and to enable you to conceive the process more vividly, you will find a pretty accurate representation of a plough at work in Plate XIII.

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* Johnston's Elements of Agricultural Chemistry, p. 125–6.

† See the practical application of this rule on a large scale illustrated in Denton on Model-Mapping, p. 35.

‡ Dickson's Husbandry of the Ancients, vol. i. p. 370.

(1114.) The first thing that will strike you is the extreme simplicity of the whole arrangement of the horses, harness, plough, and man, impressing you with the satisfactory feeling that no part of it can go wrong, and affording you a happy illustration of a complicated arrangement performing complicated work by a simple action. On examining particulars, you will find the *collar*, better seen in fig. 197, around the horse's neck, serving as a padding to preserve his shoulders from injury while pressing forward to the draught. Embracing a groove in the anterior part of the collar, are the *haims*, composed of two pieces of wood, curved towards their lower extremities, which are hooked and attached together by means of a small chain, and their upper extremities held tight by means of a leather strap and buckle; and they are moreover provided on each side with an iron hook, to which the object of draught is attached. The horse is yoked to the swing-trees by light chains, called *trace-chains*, which are linked on one end to the hooks of the haims, and hooked at the other into the eyes of the swing-trees. A *back-band* of leather put across the back, near the groins of the horse, supports the trace-chains by means of simple hooks. The *bridle* has blinders, and while the horse is in draught, it is customary to hang the *bearing-reins* over the tops of the haims. In some parts of the country, there are no *blinders;* and there is no doubt that many horses so brought up will work very well without them. But in cases of horses of so timid a nature as to be easily frightened at distant objects, and those of so careless a disposition as to look much about them, they are useful in keeping the attention of the horse to his work. You observe there are two horses, the draught of the common plough requiring that number, which are yoked by the trace-chains to the *swing-trees,* which, on being hooked to the draught-swivel of the bridle of the plough, enable the horses to exercise their united strength on that single point; and being yoked a-breast, they are enabled to exert their united strength much more effectually than if yoked a-trip—that is, one before the other. The two horses are kept together either by a *leather-strap,* buckled at each end to the bridle-ring, or by a *short rein* of rope passed from the bridle-ring to the shoulder of each horse, where it is fastened to the end of the trace-chain with a knot. The strap prevents the horses separating beyond its length, but allows their heads to move about loosely; the short reins prevent them not only separating, but keep their heads steady; and on this account, horses fastened with reins can be turned round more quickly and simultaneously than with the strap. The ploughman guides the horses with *plough-reins*, made of rein-rope, which pass from both stilts to the bridle-ring of each horse, along the outermost side of the horse, threading in their way a ring on the back-band and sometimes another on the haims. The reins are looped at the end next the ploughman, and conveniently placed for him under the ends of pieces of hard leather screwed to the foremost end of the helves; or small rings are sometimes put there to fasten the reins to. In many places, only one rein is attached to the near-side horse, and in others the horses are guided solely by the voice. It is perfectly obvious that the ploughman must have a better and quicker command over his horses with a double than a single rein, and very much more so than by the voice alone.

(1115.) Thus harnessed, each horse has not much weight to bear, nor is its harness costly, though made of the strongest harness leather, as this statement will shew :—

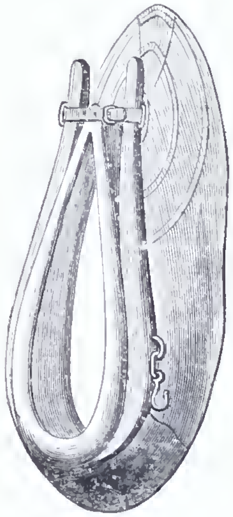
	Weight.		Value.		
Collar, ...	15 lb.		L.1	0	0
Haims, when covered with plate-iron, and with a strap, .	7		0	5	6
Bridle, ...	4½		0	10	0
Back-band, . . .	3½		0	8	0
Chains, ...	8	at 7d. per lb.,	0	4	8
Total, . .	38 lb	, and for each horse,	L.2	8	2

When compared with the weight of English harness, these are little more than feather-weight.

(1116.) The *collars* are differently mounted in the *cape* in different parts of the country. The use of the cape is to prevent rain falling upon the top of the shoulder, and getting between the collar and shoulder, where, in draught, it would heat and blister the skin. In the Lothians, the cape of the form of fig. 197 is both neat and convenient. In Forfarshire, and somewhat more northerly, it is of the form of fig. 198, which lies flatter and comes farther back than the former; and it is certainly a complete protection from rain; but it makes the collar rather heavy, and its own weight is apt to loosen the sewing of white sheep-skin with which it is attached to the body of the collar. Fig. 199 is a form of cape common in England, which answers no purpose of protection from rain, but rather to catch the wind, and thereby obstruct the progress of the horse. Such a cape is frequently ornamented with flaring-coloured red worsted fringes round the edge, or with large tassels from the corner and middle, or even with bells.

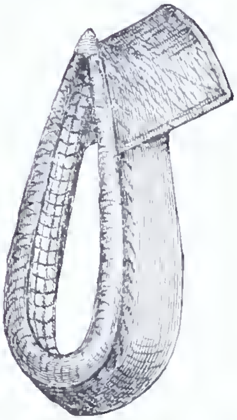
(1117.) With regard to ornamenting farm harness, it never appears, in my estimation, to greater advantage than when quite plain, and of good materials and excellent workmanship. Brass or plated buckles and brow-bands, worsted rosettes, and broad bands of leather tattooed with filligree sewing, serve only to load and cover the horses when at work, and display a wasteful and vulgar taste in the owner. Whatever temptation there may be in towns to shew off the grandeur of teams, you should shun such display of weakness in the country.

Fig. 197.



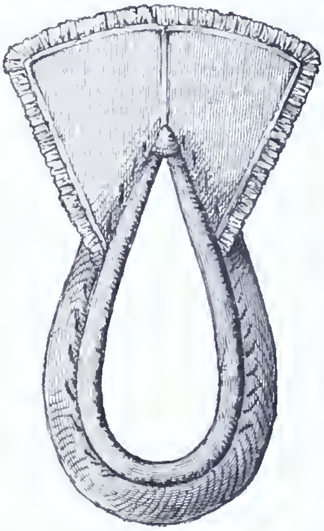
THE LOTHIAN DRAUGHT-HORSE COLLAR AND HAIMS.

Fig. 198.



THE FORFARSHIRE DRAUGHT-HORSE COLLAR.

Fig. 199.



THE ENGLISH DRAUGHT-HORSE COLLAR.

(1118.) The English farmer is not unfrequently recommended by writers on agriculture to adopt the 2-horse plan of working the plough; but the recommendation is never accompanied with such a description of the plough as any farmer could understand it, who had never seen a plough with 2 horses at work; and it is not enough to tell people to adopt this or that plan, without putting it in their power to understand what is recommended. To enable the English farmer, who may never have chanced to see a two-horse plough at work, and to facilitate the understanding of its arrangements by those who may have seen, but not have paid sufficient attention to it, the figure on Plate XIII. has been executed with a regard to shew the just proportions of the various parts of the plough and the harness. The plough has been sufficiently well explained already; and keeping in mind the relative proportions of its parts, those of the horse and harness may be ascertained from this plate; for so practically correct are those proportions, that any one desirous of mounting a plough in a similar manner may easily do so from this figure before them.

(1119.) Although the reins alone are sufficient to guide the horses in the direction they should go, and I have seen a ploughman both deaf and dumb manage a pair of horses with uncommon dexterity, yet the voice is a ready assistance to the hands, the intonations of which horses obey with celerity, and the modulations of which they understand, whether expressive of displeasure or otherwise. Indeed, in some of the midland counties of Scotland it is no uncommon occurrence to observe the ploughmen guiding their horses, both in the field and on the road, with nothing but the voice ; but the practice is not commendable, inasmuch as those accustomed to it fall into the practice of constantly roaring to their horses, which at length become regardless of the noise, especially at the plough ; and on the road, the driver has no command over them, in any case even of the slightest emergency, when he is obliged to hurry and seize the bridle of the horse nearest to him at the time; and should one or both horses evince restiveness, when he can only have the command of one by the bridle, he runs the risk of being overcome by the other or by the cart.

(1120.) The language addressed to horses varies as much as even the dialects are observed to do in different parts of the country. One word, *Wo*, to stop, seems, however, to be in general use. The motions required to be performed by the horse at work, are, to go forward, to go backward, to go from you, and to come towards you, and the cessation of all these, namely, to stop or stand still.

To lessen or cease motion.—The word *Wo*, is the common one for a cessation of motion ; and it is also used to the making any sort of motion slower ; and it also means to be careful, or cautious, or not be afraid, when it is pronounced with some duration, such as *Wo-o-o*. In some parts, as in Forfarshire, *Stand* has a similar signification ; but to stand without any movement at all, the word *Still* is there employed. In England, *Wo* is to stop.

To go forward.—The name of the leader is usually pronounced, as also the well-known *Chuck, Chuck*, made with the tongue at the side of the mouth, while impelling the breath.

To step backward.—*Back* is the only word I can remember to have heard for this motion.

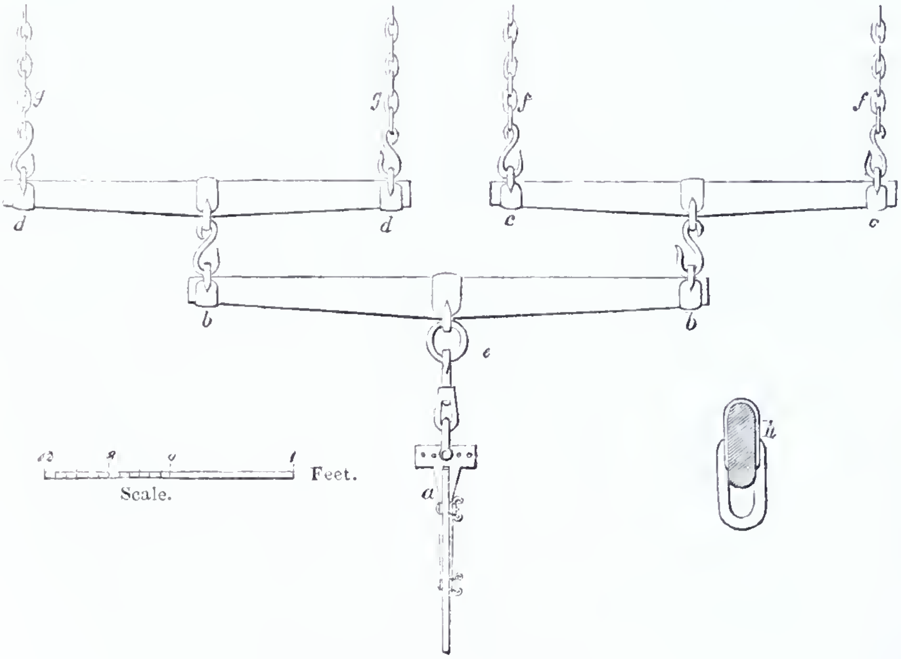
To come towards you.—*Hie* is used in all the border counties of England and Scotland ; *Hie here, Come ather*, are common in the midland counties of Scotland. In towns one hears frequently *Wynd* and *Vane*. In the west of England *Wo-e* is used.

To go from you.—*Hup* is the counterpart to hie in the southern counties, whilst *haud aff* is the language of the midland counties; and in towns, *Haap* is used where wynd is heard, and *Hip* bears a similar relation to vane. In the west of England *Gee agen* is used.

In all these cases, the speaker is supposed to be on what is called the *near-side* of the horse, that is, on the horse's left side. As a single word is more convenient to use than a sentence, I shall employ the simple and easily pronounced words *hup* and *hie* when having occasion to describe any piece of work, in which horses are employed.

(1121.) [The *swingle* or *swing-trees*, *whipple-trees*, *draught-bars*, or simply *bars*, for by all these names are they known, are those bars by which horses are yoked to the plough, harrows, and other implements. In the plough yoke a set of swing-trees consist of 3, as represented in fig. 200, where *a* points out the bridle of the plough, *b b* the main swing-tree attached immediately to the bridle, *c c* the furrow or off-side little swing-tree, and *d d* the land or nigh-side little tree, arranged in the position in which they are employed in working. The length of the main-tree, between the points of attachment for the small trees, is generally 3½ feet, but this may be varied more or less, the length of the little trees is usually 3 feet between the points of attachment of the trace chain, but this also is subject to variation.

Fig. 200.



THE SWING-TREES FOR TWO HORSES.

(1122.) Swing-trees are for the most part made of wood, oak or ash being most generally used; but the former, if sound English oak, is by much the most durable, though good Scotch ash is the strongest, so long as it remains sound, but it is liable, by long exposure, to a species of decay resembling dry-rot. As it is always of importance to know the why and wherefore of every thing, I shall here point out how it may be known when a swing-tree is of a proper degree of strength. A swing-tree, when in the yoke, undergoes a strain similar in practice to that of a beam supported at both ends and loaded at the middle, and the strength of beams or of swing-trees in this state are proportional to their breadths multiplied into the square of their depths and divided by their lengths. It is to be understood that the *depth* here expressed is that dimension of the swing-tree that lies in the direction of the strain, or what in the language of agricultural mechanics is called the *breadth* of the swing-tree. To apply the above expression to practice, suppose a swing-tree of 3 feet in length between the points of attachment for the draught, that its breadth is $1\frac{1}{2}$ inches and depth 3 inches, and another of the same breadth and depth but whose length is 6 feet, then in the case of the first we have $\frac{1.5 \times 3 \times 3}{3 \text{ feet}} = 4.5$; and in the second we have $\frac{1.5 \times 3 \times 3}{6} = 2.25$, the strength of these two being as 2 to 1; and to make the 6 feet swing-tree of equal strength with the other the *breadth* must be increased directly as the length, that is to say, doubled, or the depth increased, so that its *square* shall be double that of the former. Hence a swing-tree of 6 feet long, and having a breadth of $1\frac{1}{2}$ inch and depth $4\frac{1}{2}$ inches, will be equal in strength to the 3 feet swing-tree with a breadth of $1\frac{1}{2}$ and depth of 3 inches; but the depth remaining equal, the breadth is required to be *doubled* or made 3 inches for the 6-feet swing-tree.

(1123.) To find the absolute strength of a bar or beam, situate as above described, we have this rule. Multiply the breadth in inches by the square of the depth in inches, divide the product by the length in feet, and multiply the quotient by the constant 660 if for oak, or by 740 if for ash, the product will be the force in pounds that would break the swing-tree or the beam.* Here, then, taking the former dimensions as of a small swing-tree, $\frac{1.5 \times 3^2 \times 740}{3} = 3333$ lb. the absolute force that would break the tree, but taking into account the defect that all woods are liable to break from crossing the fibres and other contingent defects, we may allow $\frac{1}{2}$ to go for security against such contingencies, leaving a disposable strength equal to 1666 lb. It has been shewn (808.) that the usual force exerted by a horse in the plough does not exceed 168 lb., but it occasionally rises to 300 lb., and on accidental occasions even to 600 lb.; but this is not much beyond $\frac{1}{3}$ of the disposable strength of the 3 feet swing-tree when its breadth and depth are $1\frac{1}{2}$ and 3 inches. The depth of such trees may therefore be safely reduced to $2\frac{1}{2}$ inches, and still retain a sufficient degree of strength to resist any possible force that can come upon it. In the large swing-tree the same rule applies; suppose its length between the points of attachment to be 3 feet 9 inches, its breadth $1\frac{3}{4}$ inch, and depth $3\frac{1}{2}$ inches, the material being ash as before; then $\frac{1.75 \times 3.5^2 \times 740}{3.75} = 4230$ lb.; reducing this $\frac{1}{2}$ for security, there remain 2115 lb., but the greatest force that may be calculated upon from 2 horses is 1200 lb.; we have, therefore, nearly double security in this size of large swing-tree.

(1124.) In proportioning the strength of swing-trees to any particular draught, let the greatest possible amount of force be calculated that can be applied to each end of the tree, the sum of these will be the opposing force as applied at the middle, and this may be taken as above (1123.) at 600 lb. for each horse, but for security let it be 3 times or 1800 lb. each horse H, any number of horses being m H, and having fixed upon a breadth B for the tree, and L the length, C being the constant as before, then the depth D will be found thus, $\frac{L \times m H}{B \times C} = D^2$, or, in words, multiply the length into as many times 1800 lb. as there are to be horses applied to the tree, divide the product by the *constant* (740 for ash, or 660 for oak) multiplied into the breadth, the quotient will be the square of the depth, and the square-root of this will be the depth of the swing-tree with ample allowance for assurance strength. In all cases the depth at the ends may be reduced to $\frac{3}{4}$ of that of the middle.

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* Tredgold's Carpentery, art. 110.

(1125.) Wooden swingtrees ought always to be fitted up with clasp and eye mounting of the best wrought iron, from 2 to 2½ inches broad, about $\frac{3}{16}$ inch thick in the middle parts, and worked off to a thin edge at the sides; the part forming the eye may range from $\frac{1}{2}$ inch diameter in the centre eye of the large tree to $\frac{3}{8}$ inch in the end clasps of the small trees; and they are applied to the wood in a hot state, which, by cooling, makes them take a firm seat. In the main tree, the middle clasp has usually a ring or a link *c* welded into it, by which the set is attached to the hook of the plough's bridle; the two end clasps have their eyes on the opposite edge of the swing-trees, with sufficient opening in the eyes to receive the S hooks of the small tree. The small are trees furnished with the S hooks, by which they are appended to the ends of the main trees; and end clasps are adapted to receive the hooks of the trace-chains *f f*, *g g*, a small part only of which are shewn in the figure. The detached figure *h* is a transverse section of a tree shewing the form of the clasps; the scale of which is double the size of the principal figure in the cut.

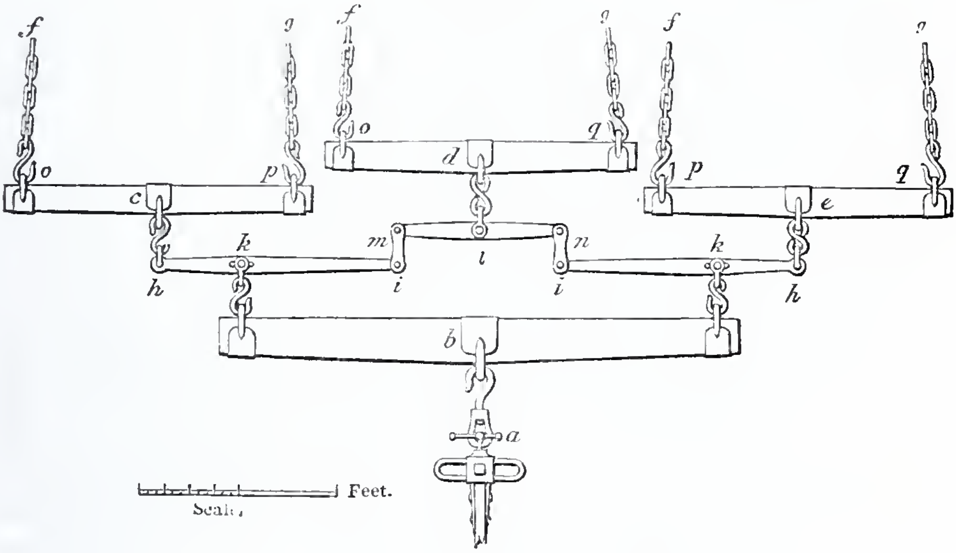
(1126.) Though wood has hitherto been the material chiefly used for swing-trees, there have been some successful trials of malleable iron for the purpose. These have been variously constructed, in some cases entirely of sheet iron turned round into a form somewhat resembling the wooden trees; but in this form, either the iron must be thin, or the bar must be inconveniently heavy; if the former, durability becomes limited, by reason of the oxidation of the iron acting over a large surface, and soon destroying the fabric. Another method has been to form a diamond-shaped truss of solid iron rods, the diamond being very much elongated, its length being 3 feet, and its breadth about 4 inches, with a stretcher between the obtuse angles. A third has been tried, consisting of a straight welded tube of malleable iron, about 3 feet long and $\frac{3}{4}$ inch diameter. In this tube, acting as a strut, a tension rod, also of malleable iron, is applied with a deflection of 4 inches, the extremities of the tension-rod being brought into contact by welding or rivetting with the ends of the tubular strut, and eyes formed at the ends and middle, for the attachment of the hooks and chains. A tree thus formed is sufficiently strong for every purpose to which it is applied, while its weight does not exceed 7 lb, and the weight of a wooden tree, with its mounting, frequently weighs 8 lb. The price of a set of common wooden trees, with the iron mounting, is 12s., and of the iron trees 18s.

(1127.) The foregoing remarks apply, so far as arrangement goes, to the common 2-horse swing-trees; but the various modes of applying horse-power, both as regards number and position of the horses, require further illustration.

The next I shall notice, therefore, is the 3-*horse yoke*, of which there are various modes, the simplest of which is, first, a pair, working in the common trees, fig. 200; and for the third horse, a light chain is attached by a shackle to the middle of the main bar *b b*. To this chain the third horse is yoked, taking his place in front of the other two, in unicorn fashion. This yoke is defective, inasmuch as there are no means of equalizing the draught of the third horse.

(1128.) Perhaps the most perfect method of yoking a 3-horse team, whether abreast or unicorn-fashion, is that by the compensation levers, fig. 201—a statical combination, which is at once correct in its equalisation, scientific in its principles, and elegant in its arrangement; and I have to regret my inability to single out the person who first applied it. The apparatus in the figure is represented as applied to the subsoil plough; *a* being the bridle of that plough; *b* is a main swing-tree, 5 feet in length, and of strength proportioned to the draught of 3 horses; and *c d e* are three small common trees, one for each horse. The trace-chains are here broken off at *f*, *g*, respectively, but are to be conceived as extending forward to the shoulders of the horses. Between the main swing-tree and the three small ones the compensating apparatus is placed, as in the figure, consisting of three levers, usually constructed of iron. Two of these, *h i* and *h i*, are levers of the first order, but with unequal arms, the fulcrum *k* being fixed at $\frac{1}{3}$ of the entire length from the outward end of each; the arms of these levers are therefore in the proportion of 2 to 1, and the entire length of each between the points of attachment is 27 inches. A connecting lever *l*, of equal arms, and 20 inches in length, is jointed to the longer arms *i i* of the former, by means of the double short links *m*, *n*. The two levers *h i*, *h i*, are hooked by means of their shackles at *k* to the main swing-tree *b*; and the three small swing-trees *c*, *d*, *e*, are hooked to the compensation lever at *h*, *h* and *l*. From the mechanical arrangement of these levers, if the whole resistance at *a* be taken at 600 lb., *k* and *k* will each require an exertion of 300 lb. to overcome the resistance. But these two forces fall to be subdivided in the proportion of the arms of the levers *h i*,

Fig. 201.



THE SWING-TREES FOR THREE HORSES.

$\frac{2}{3}$ of each, or 200 lb., being allotted to the arms *h*, and the remaining $\frac{1}{3}$, 100 lb. to the arms *i*, which brings the system to an equilibrium. The two forces *i*, *i*, being conjoined by means of the connecting levers *m*, *n*, their union produces a force of 200 lb., thus equalizing the three ultimate forces *h l h* to 200 lb. each, and these three combined are equal to the whole resistance *a*; and the 3 horses that are yoked to the swing-tree *c*, *d*, *e*, are subjected to equal exertion, whatever may be the amount of resistance at *a* which has to be overcome.

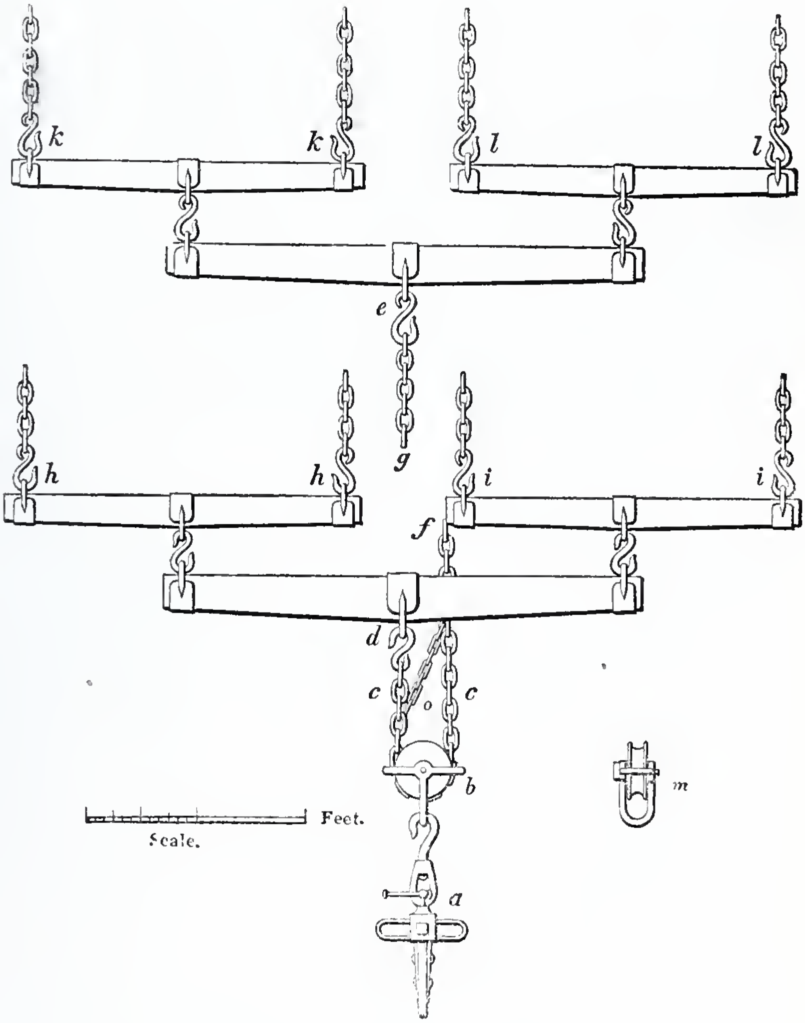
(1129.) The judicious farmer will frequently see the propriety of lightening the labour of some individual horse; and this is easily accomplished by the compensation apparatus. For this purpose, one or more holes are perforated in the levers *h i*, on each side of the true fulcrum *k*, to receive the bolt of the small shackles *k*. By shifting the shackle and bolt, the relation of the forces *h* and *i* are changed, and that in any proportion that may be desired; but it is necessary to observe that the *distance* of the additional holes, on either side of the central hole or fulcrum of equilibrium in the system, should be in the same proportion as the length of the arms in which the holes are perforated. Thus, if the distance between those in the short arm is half an inch, those in the longer arm should be an inch. By such arrangement, every increase to the exertion of the power, whether on the long or the short arm, would be equal.

(1130.) The same principle of compensation has been applied to various ways of yoking, one of which is a complicated form of that just described. The main swing-tree and the compensation levers are the same, except that they may be a few inches shorter in all the arms, and the middle one of the three small swing-trees also shorter. The yoking is performed in this manner. The nigh trace-chain of the nigh horse is hooked to the end *o* of the swing-tree *c*, and his off-side trace-chain to the end *o* of the swing-tree *d*. The middle horse has his nigh-side chain hooked to the end *p* of the swing-tree *c*; while his off-side chain goes to the end *p* of the swing-tree *e*, and the off-side horse has his nigh-side chain attached to the end *q* of the middle swing-tree *d*, and his off-side to *q* of the swing-tree *e*. This system of yoking is complicated, and though in principle it equalizes the forces so long as all the horses keep equally a-head, yet it is in some degree faulty. Whenever the middle horse gets either behind or before his proper station,—or out of that position which keeps all the swing-trees parallel to each other,—the outside horses have a larger share of the draught upon one shoulder than upon the other, and as this produces an unnecessary fatigue to the animal, it should be avoided. Such irregularity cannot occur with the simple mode of giving each horse his own swing-tree.

(1131.) A modification of this compensation yoke has been contrived, as I am informed, by Mr Bauchop, Bogend, Stirlingshire. The compensation levers are formed of wood, and in place of the connecting levers *l*, fig. 201, a chain, 2 feet in length, connects the ends *i i* of the levers *h i*; and in the bight of the chain, as at *k*, a pulley and strap are placed, to which a *soam* chain is hooked; the pulley from it oscillating in the bight of the chain serves the same purpose as the connecting lever *l*. In this mode of yoking, the horses work in unicorn-team, the middle horse pulling by the soam-chain.

(1132.) *In the yoking of 4 horses*, various modes are also adopted. The old and simple method is for the plough horses to draw by a set of common swing-trees, fig. 200; and to the centre of the main swing-tree at *e* a soam-chain is hooked by means of a shackle or otherwise. The leading horses are thus yoked by a second set of common swing-trees to the end of the soam. This is now seldom employed, but an improved method of applying the soam has been adopted in its place, which is represented by fig. 202, where *a* is the bridle of the plough, with its swivel hook. A pulley *b* of cast iron, 6 inches diameter mounted in an iron frame, of which an edge-view is given at *m*, is attached to the hook of the bridle. A link chain *c* is rove through the frame of the pulley; and to one end of it, the short end, is hooked the main swing-tree *d* of a set of common trees for the plough horses. The other end of the chain passes forward to a sufficient distance to allow the leading horses room to work; and to it is hooked the second set of common swing-trees at *e* for the leaders. In the figure, a part of the chain, from *f* to *g*, is broken off; but the full length is about 11 feet. In this yoke, the trace-chains of the nigh-side hind horse are hooked to the swing-trees at *h h*, and those of the off-side horse at *i i*, the leaders being yoked at *k k* and *l l* respectively. In this arrangement, the balance of forces is perfectly preserved; for the hind horses and the leaders, as they pull

Fig. 202.

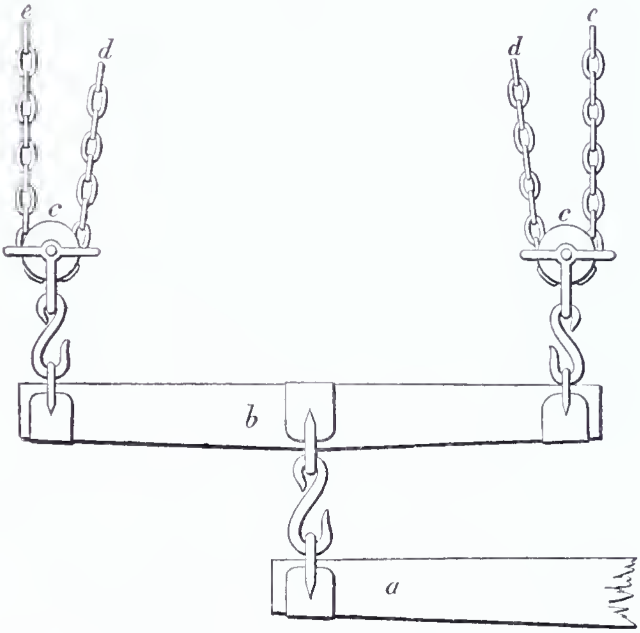


THE SWING-TREES FOR FOUR HORSES.

at opposing ends of the chain passing round a pulley, which must inevitably be always in equilibrium, each pair of horses has an equal share of the draught ; and from the principles of the common swing trees through which each pair acts, the individual horses must have an equally perfect division of the labour, unless this equilibrium has been removed for the purpose of easing a weaker horse. In order to prevent either the hind horses or the leaders from slipping too much a-head, it is common to apply a light check-chain *o*, of about 15 inches long, connecting the two parts of the main-chain, so as to allow only a short oscillation round the pulley, which is limited by the check-chain. When this is adopted, care should be taken never to allow the check-chain to remain upon the stretch ; for if it do so, the advantage of equalization in the yoke is lost, and it becomes no better than the simple soam. In all cases of using a chain, that part of it which passes forward between the hind horses must be borne up by means of attachment to their back bands, or suspended from their collars.

(1133.) Mr Stirling of Glenbervie, Stirlingshire, recommends a method of yoking a team of four horses in pairs, the arrangements of which are represented in fig. 203 ; *a* is part of a main swing-tree of the common length, *b* a small swing-tree about 4 inches longer than the usual length, but both mounted in the usual form, except that, at each end of the small swing-trees, cast-iron pulleys *c c*, of 3 or 4 inches diameter, and set in an iron frame, are hooked on to the eyes of the swing-tree. The common trace-chains are rove through the frames of these pulleys, as in the figure, the ends *d d* of the chains are prolonged forward to the proper length for the nigh hind horse, and the ends *e e* are extended to the nigh leader. At the opposite end of the main swing-tree, which, in this figure, is cut off, the same arrangement is repeated for the off-side horses. The principle of action in this yoke is simple and effective, though different in effect

Fig. 203.



THE SWING-TREES ALSO FOR FOUR HORSES.

from the former. There the two hind horses are equalized through the medium of their set of common swing-trees. The leading horses are alike equalized by their set, and thus the two pairs balance each other through the medium of the soam. Here, on the other hand, the two nigh-side horses have their forces equalized through the trace-chains which are common to both by passing over the pulleys *c c*, and the same holds in respect to the two off-sides. The couple of nigh-side and of off-side horses, again, are equalized through the medium of the one set of swing-trees. In both, therefore, the principle of equalization is complete, but there is a trifling difference in their economy. In the yoke, fig. 202, which I call the *cross balance yoke*, the soam-chain and pulley are the only articles required in addition to the every-day geer. In that of fig. 203, which I call the *running balance yoke*, there is first the set of swing-trees, which, as they have to resist the force of 4 horses, must in all their parts be made stronger than the common set, agreeably to the rules before laid down; and to which is added the 4 pulleys, all of which are applicable only to this yoke. The trace-chain, though not necessarily stronger than those for common use, is required about three times longer than single horse-chains, that is to say, four horses will require the chains of six; but the chains of the leaders are more conveniently supported when they pass along the sides of the hind horses, and it is free of the set of swing-trees which dangle behind the leaders, of the method fig. 202.

(1134.) In cases where 6, 8, and even 12 horses are required, such as for trenching, subsoil-ploughing, and especially draining with the plough, the yoking is accomplished by modifications and extension of the principles here laid down; for example, a team of 6 can be very conveniently applied with equalized effect by employing the compensation levers of fig. 202, along with 3 single swing-trees with pulleys at each end and running trace-chains, as in fig. 203.—J. S.]

29. OF PLOUGHING STUBBLE AND LEA GROUND.

> "'Tis time to clear your ploughshare in the glebe."
>
> GRAHAM.

(1135.) When you take an extensive glance over the fields immediately after harvest, when the crop has been gathered into the stackyard, you perceive that a large proportion of them are in stubble, whilst others are occupied by grass, turnips, and young wheat. On examining the stubbled fields particularly, you will observe young grass amongst the stubble in some fields, and nothing but stubble in others. You could not, of yourself, discover at once, that these various states of the fields bear a certain proportion to one another, though they really do; and the cause of their being in those proportions, is, that they are cultivated under what is termed a "regular rotation of crops," which, when followed out, necessarily causes every field, in its turn, to carry the same series of crops. The numbers composing the series depend on the nature of the soil, and it shall be my duty to make you acquainted with them in due time. Meantime, suffice it to intimate, that when the stubble is in that state, the beginning of the agricultural year is arrived, when certain parts of it must undergo a change, and be transformed into those which follow the ones you find them in. Now, that part of the stubble-land which is devoid of any crop is the first to undergo a change, and it is effected by the plough, not at random, but by the application of those principles which have already been explained to you when we considered the "various modes of ploughing land into ridges," from pages 464 to 481, where, as you may remember, the mode of ploughing was said to be determined by the nature of the soil and subsoil. The stubble-land is generally all ploughed before the lea is commenced with, and that part which is to bear the potato-crop next spring is first ploughed, then that for the turnip-crop, and last of all for the bare fallow, when there is any.

(1136.) On *clay soil* you will find the stubbled ridges of a rounded form, having been at least twice gathered up, fig. 139; and the way to keep them in a dry state during winter, on a considerable declivity, is to cleave them down without a gore-furrow, fig. 140, and without a mould-furrow, fig. 134, or to cleave them down with gore-furrows, fig. 141, and mould-furrows, when clay-land is flat. On *less strong soil*, casting with a gore-furrow (831.) will preserve land dry whether it be flat or on a declivity. On *light loams*, casting without gore-furrows, fig. 135, will serve the purpose. And on *sandy* and *gravelly soils*, crown and furrow (827) is the most appropriate mode of ploughing stubble. It is rare that stubble-land is subjected to any other mode of ploughing in winter. Snow should never be ploughed in, nor the ground turned over when affected by frost, nor should strong clay soil be stirred when very wet, as it is apt to become very hard in spring, and of course more difficult to work.

(1137.) In every variety of soil, ploughed in the forms just described for winter care should be taken to have plenty of channels, or *gaws* or *grips*, as they are usually termed in Scotland, cut in the hollowest places, so as surface-water may have them at every point by which to escape into the nearest open ditch. The gaws are first drawn by the plough laying them open like a feering, taking, in all cases, the hollowest parts of the ground, whether these may happen to cross the ridges or go along the open furrows; and they are immediately afterwards cleared out with the spade of the *loose earth* left by the plough, and cast abroad over the surface. The fall in the gaws is made to tend towards a point or points best adapted to carry off surface-water by the shortest route, and do the least injury to the soil. The ends of the open furrows which terminate at the furrow along the side of the lowest head-ridge, as well as this furrow itself, should be cleared out with the spade, and cuts made at the hollowest places across the head-ridge into the ditch. This precaution of gaw-cutting should never be neglected in winter in any kind of soil, the stronger soils requiring more gaws than the lighter; for as there is no foreseeing the injuries which a single deluge of rain may commit, it is never neglected by the provident farmer, though many small farmers, to their own loss, pay little heed to the necessity of its observance.

(1138.) With regard to the ploughing of *lea ground*, the most usual form in *strong soil* is to cast with a gore-furrow, fig. 136, and on *less strong soil* the same form of ploughing without a gore-furrow, whilst on the lightest soils of all, the crown and furrow is in most common use (827.). Gathering up is a rare form of furrow for lea, though it is occasionally practised on strong soil after gathered up or cast ridges, when it is a rather difficult operation to plough the furrow-brows and open furrows as they should be. The oldest lea is first ploughed, that the slices may have time to mellow by exposure to the winter air, and that which is on the strongest land is for the same reason ploughed before that on light. Lea should never be ploughed in frosty weather, that is, as long as the ground is at all affected by frost, nor when there is rime on the grass, nor when the ground is very soft with rain; because when ice or rime is ploughed down, the non-conducting property of grass and earth, in regard to heat and cold, preserves the ice in an unaltered state so long as to chill the ground to a late period of the season, and when the ground is too soft, the horses not only cut it into pieces with their feet, but the furrow-slice is apt to be squeezed out of its proper shape by the mould-board. Nor should lea be ploughed when hard with drought, as the plough in that case will take too shallow a furrow-slice, and raise the ground in broad thin slabs instead of proper furrow-slices. A semi-moist state of the ground in fresh weather is that which should be chosen for ploughing lea. Gaws should not be neglected to be cut after lea-ploughing, especially in the fields first ploughed, and in strong land, always whether early or late ploughed.

(1139.) It is a slovenly though too common a practice to allow the headridges to remain unploughed for a considerable time after the rest of the field has been finished ploughing, and the neglect is most frequently observed on stubble ground. The reasoning on the matter is, that as all the draughts cannot be employed on the headridges, it is a pity to break their number in beginning another entire field, and this reason would be a good one in summer when there is little chance of bad weather occurring; but in winter it has no force at all, for the gaw cuts cannot be properly executed until the field is entirely ploughed, and to leave a ploughed field to the risk of injury from wet weather, even for a day longer than you can help, shews little regard to future consequences, which may turn out far more serious than the beginning to plough a new field without all the draughts. No doubt, when land has been thorough-drained, there is less dread of ill consequences from the neglect of gaw-cutting; but even in the most favoured circumstances of drained land, I think it imprudent to leave isolated hollows in fields, and such are to be found in numbers on every farm, without the means of getting rid of any torrent of water that may fall at an unexpected time. Let, therefore, as many draughts remain in the field as will plough both headridges during the next day at longest, and if they can be finished in one yoking so much the better.

(1140.) With regard to the mode of ploughing headridges for a winter furrow some consideration is requisite. In stubble, should the former furrow have been cast with or without a gore-furrow, then on reversing the casting, a ridge will be left on each side of the field, which will be most conveniently ploughed along with the headridges by the plough going round parallel to all the fences of the field, and laying the furrow-slices towards them. The same plan could be adopted in ploughing lea in the same circumstances. Should the furrow given to the stubble have been a cleaving down with or without gore-furrows, then the headridges should be cloven down with a gore-furrow along the ends of the ridges, and mould furrows along their own crowns. On the ridges having been crown and furrowed, the headridges may be gathered up in early and late lea ploughing and in stubble, they may be cloven down without a gore-furrow along the ends of the ridges, especially in the upper headridge, and the half-ridge left on each side of the field may be ploughed by going the half of every bout empty; but a better plan would be, *only if the ridges of the field are short*, to plough half of each headridge towards the ends of the ridges, going the round of the field, and passing up and down upon the half-ridge on each side empty, and then to plough those half-ridges with the other half of the headridges in a circuit, laying the furrow-slice still towards the ridges, all which will have the effect of casting the headridges, towards the ends of the ridges. When the ridges have been ploughed in a completed form, a convenient mode of ploughing the headridges on strong land is to gather them up, first making an open feering along the crowns.

(1141.) Whatever mode of ploughing the land is subjected to, you should take special care that it be ploughed for a winter furrow in the best manner. The furrow-slice should be of the requisite depth, whether of 5 inches on the oldest lea, or 7 inches on the most friable ground; and it should also be of the requisite breadth of 9 inches in the former case, and of 10 in the latter; but as ploughmen incline to hold a shallower furrow than it should be, to make the labour easier to themselves, there is less likelihood of their making a narrower furrow than it should be, a shallow and broad furrow conferring both ease on themselves, and getting over the ground quickly. A proper furrow-slice in land not in grass, or, as it is termed, in *red* land, should never be less than 9 inches in breadth and 6 inches in depth on the strongest soil, and 10 inches in breadth and 7 inches in depth on lighter soils. On grass-land of strong soil, or on land of any texture that has lain long in grass, 9 inches of breadth and 5 inches of depth is as large a furrow-slice as may possibly be obtained, but on lighter soil, with comparatively young grass, a furrow-slice of 10 inches by 6 and even 7 is easily turned over. At all seasons, but especially for a winter furrow, you should endeavour to establish for yourself a character for deep and correct ploughing.

(1142.) *Correct ploughing* possesses these characteristics:—The furrow-slices should be quite straight; for a ploughman that cannot hold a straight furrow is unworthy of his charge. The furrow-slices should be quite parallel in length, and this property shews that they have been turned over of an uniform thickness, for thick and thin slices lying together present irregularly horizontal lines. The furrow-slices should be of the same height, which shews that they have been cut of the same breadth, for slices of different breadths, laid together at whatever angle, present unequal vertical lines. The furrow-slices should present to the eye a similar form of crest and equal surface; because where one furrow-slice exhibits a narrower surface than it should have, it has been covered with a broader slice than it should be; and where it displays a broader surface than it should, it is so exposed by a narrower slice than it should be lying upon it. The furrow-slices should have their back and face parallel, and to discover this property requires rather minute examination after the land has been ploughed; but it is easily ascertained at the time of ploughing. The ground, on being ploughed, should feel equally firm under the foot at all places, for slices in a more upright position than they should be, not only feel hard and unsteady, but will allow the seed-corn to fall down between them and become buried. Furrow-slices in too flat a state always yield considerably to the pressure of the foot; and they are then too much drawn, and afford insufficient mould for the seed. Furrow-slices should lie over at the same angle, and it is demonstrable that the largest extent of surface exposed to the action of the air is when they are laid over at an angle of 45°, thus presenting crests in the best possible position for the action of the harrows. Crowns of ridges formed by the meeting of opposite furrow-slices, should neither be elevated nor depressed in regard to the rest of the ridge, although ploughmen often commit the error of raising the crowns too high into a crest, the fault being easily committed by not giving the feered furrow-slices sufficient room to meet, and thereby pressing them upon one another. The furrow-brows should have slices uniform with the rest of the ridge, but ploughmen are very apt to miscalculate the width of the slices near the sides of the ridges, for if the specific number of furrow-slices into which the whole ridge should be ploughed are too narrow, the last slice of the furrow-brow will be too broad, and will therefore lie over too flat; and should this too broad space be divided into two furrows, each slice will be too narrow and stand too upright. When the furrow-brows are ill made, the mould-furrows cannot be proportionately ploughed out; because, if the space between the furrow-brows is too wide, the mould-furrows must be made too deep to fill up all the space, and *vice versa*. If the furrow-brow slices are laid too flat, the mould-furrows will be apt to throw too much earth upon their edges next the open furrow, and there make them too high. When the furrow-brows of adjoining ridges are not ploughed alike, one side of the open-furrow will require a deeper mould-furrow than the other.

(1143.) You thus see that many particulars have to be attended to in ploughing land into a ridge of the most perfect form. Ploughmen differ much in bestowing attention on these particulars; some can never make a good crown, others a good furrow-brow and open furrow, whilst others will make them all in a passable, but still objectionable manner. This last class of ploughmen, however, is preferable to the other, because the injurious effects of the bad ploughing of the former are obvious; whereas the effects of mediocre compared with first-rate ploughing are not easy to ascertain, though no doubt the difference of their effects must be considerable in many respects. "It is well known," observes Sir John Sinclair, "that the horses of a good ploughman suffer less from the work than those intrusted to an awkward and unskilful hand, and that a material difference will be found in the crops of those ridges tilled by a bad ploughman, when compared to any part of the field where the operation has been judiciously performed."* Marshall contends that want of good tillage incurs a loss of as much as ¼ of the crops throughout the kingdom,† which may be an approximation to the truth in his day; but ploughing is certainly now better performed in Scotland than it was, though it must be owned that by far the greatest part of the process is yet of a mediocre description, and the reasons for the mediocrity of the work are not difficult to find.

(1144.) *Ploughmen* cannot learn their profession at a very early age, when every profession ought to be acquired to attain a high degree of perfection in it, because ploughing requires a considerable amount of physical power, even from the most expert ploughmen, and it exacts the greatest exertion of strength by comparison from the youngest in years, and the least initiated in the art; and after young men possess sufficient strength to hold the plough, they are left to acquire a knowledge of ploughing more through sheer experience than by any tuition given them by those who are better acquainted with the art; and as excellence acquired in it cannot be bequeathed to the rising generation, its knowledge must be acquired *ab initio* by every generation. For example, to teach *boys* to plough it has been recommended "to put a cross-bar between the cheeks of the bridle, so as to keep them precisely at the same distance from each other, and then setting up a pole at the end of a furrow, exactly measured to the same line as that from which he starts, fixes his eye steadily upon it, and carries the plough in a direction precisely to that point."‡ To do all this implies that the *boy* has sufficient strength to hold a plough, which if he have, he will have come the length of a stout lad; and to "fix the eye steadily" upon a pole at a distance, while holding the plough with a staggering gait, and unable for want of breath to speak even a word to the horses, far less to guide them with the reins, is much beyond the power of any *lad*, instead of a *boy:* for it would require a very expert ploughman to do that, for all that is nothing short of feering, and none but the expertest of the ploughmen on a farm is intrusted to feer land; and, besides, no single pole always before the spectator can possibly guide any one in a straight line, for he may imagine he is moving by it in a straight line, while all the while he may be deviating very widely from it. The truth is, the young man who is desirous of becoming a ploughman in a short time should be taught day by day by an experienced ploughman to temper the irons, and guide his plough according to his strength and talents. Very few young men have, or are permitted to have such opportunities of learning, and the consequence is, that, as my observation confirms, the best ploughmen are generally those who have been taught directly by their fathers, and work constantly upon their fathers' farms.

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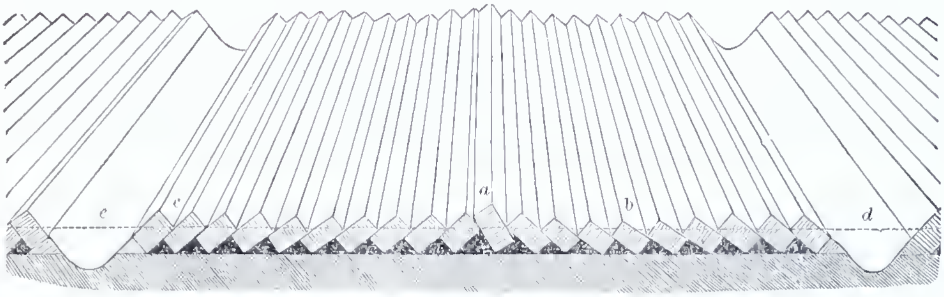
* Sinclair's Code of Agriculture, p. 298.

† Marshall's Gloucestershire, vol. i. p. 72.

‡ British Husbandry, vol. ii. p. 39.

(1145.) Were all the particulars of good ploughing mentioned above (1142.) constantly attended to, there would be no *high crowned* ridges as at *a*, fig. 204, by bringing the two feering, or the two open furrows, too close together, thereby causing the corn sown upon it to slip down both sides, and leave a space bare of seed on the best land of the ridge. There would be no *lean* flanks as at *b*, by making the furrow-slices there broader than they should be, with a view to ploughing the ridge as fast as possible, and thereby constituting a hollow which becomes a receptacle for surface-water that sours the land; or when the soil is strong, it becomes so consolidated, that it is almost sure to resist the action of the harrows, especially when passed across the ridge; or in light soil it is filled up with the loose soil drawn by the harrows from the surrounding heights. There would be no *proud furrow-brows* as at *c*, by setting up the furrow-slices there more upright than they should be, to the risk of being drawn wholly into the open furrows when the harrows catch them too forcibly on leaving the ridge when cross-harrowed. And there would be no *unequal* open furrows, as at *d*, by turning over a flatter mould-furrow on the one side than the other, which cannot fail to retain the greater quantity of seed. To extend this lengthened catalogue of ills accompanying bad ploughing, I may mention that every sort of crop grows unequally on an ill-ploughed ridge, because the soil is more kindly on the better ploughed parts; but the evils of bad ploughing are not confined to the season in which it is performed, as it renders land unequal when broken up again, and the thinner and harder portions cannot yield so abundantly as the deeper and more kindly. The line *d e*, fig. 204, shews the position of the surface before the land was ploughed, and the furrow-slices, in relation to that line, shew the unequal manner in which the ridge had been ploughed.

Fig. 204.



AN EXAMPLE OF BAD PLOUGHING.

(1146.) It seems to be a prevalent opinion among agricultural writers,* that land when ploughed receives a curvature of surface; whereas, correct ploughing, that is, making the furrow-slices on the same ridge all alike, cannot possibly give the surface any other *form* than it had before it was ploughed. If the former surface were curved, then the newly ploughed surface would also be curved; but if it were flat, the new surface will be flat also. No doubt, in gathering up a ridge, the earth displaced by the plough occupies a smaller area than it did before, but as the displacement only elevates it above its former level, the act of elevating it does not necessarily impart any curvature to it. It is quite true, however, that a ridge on being cross-harrowed, becomes curved, inasmuch as it becomes highest at the crown, because the harrows, in crossing, have a tendency to draw the soil towards the open sides of the ridge, that is, into the open furrows, where the least resistance is presented, and which will alter the uniformity of surface left by the plough; but this effect has no connection with the ploughing. Seeing this external effect produced without knowing its cause, it is equally true that most ploughmen endeavour to give the ridge a curvature, and this they accomplish by what I would designate bad ploughing; that is, they give a slight cresting to the crown, which they support with a bout or two of well-proportioned furrow-slices: they then plough the flanks with narrow and rather deep slices set up a little high, to maintain the curvature, for about four bouts more, giving the last of these bouts rather less depth and height than the rest, and the remaining three bouts next the furrow are gradually flattened towards the open furrows, which are endeavoured to be finished off to the desired curved form by the mould-furrows. This artfulness produces a ridge of pleasing enough curvature, though it is exercised by the ploughman with no intention to deceive; he, on the contrary, conceives all the while that he is displaying great skill in his art by so doing, and if he is not instructed better he will continue to practise it as an accomplishment. Such a device, however, sacrifices correct ploughing to a fancied superiority of external appearance, as much as the crested furrow formerly spoken of (764.), fig. 109. A thoroughly good ploughman, and I have known a few, but only a few, of such valuable men, avoids so objectionable a practice, and ploughs always a true sound furrow, making it larger or smaller as the particular state of the work may require.

(1147.) Without putting much value on the information, it may serve as a fact to refer to, in case it should be wanted, to state the weight of earth turned over in ploughing. If 10 inches are taken as a fair breadth for a furrow-slice, there will be 18 such slices across a ridge of 15 feet in breadth; and taking 7 inches as a proper depth for such a furrow-slice, a cross section of the slice will have 70 square inches. A cubic foot of earth is thus turned over in every 24½ inches and a little more of length of such a slice; and taking 2.7 as the specific gravity of ordinary soil, every 24½ inches and a fraction more of such a slice will weigh 12 stones 1 lb. imperial.

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* Low's Elements of Practical Agriculture, p. 152, and British Husbandry, vol. ii. p. 45.

(1148.) The usual *speed* of horses at the plough may be ascertained in this way. A ridge of 5 yards in breadth will require a length of 968 yards to contain an imperial acre; and to plough which at 9 bouts, of 10-inch breadth of furrow-slice, counting no stoppages, will make the horses walk 9⅞ miles, which in 10 hours gives a speed of 1742½ yards per hour. But as ridges are not made of 968 yards in length, and as horses cannot draw a plough that distance without being affected in their wind, and as allowance must be made for time lost in turning at the ends of the ridges, as well as for affording rest to the horses, that speed will have to be considerably increased to do that quantity of work in the time. By experiment it has been found, that 1 hour 19 minutes, out of 8 hours, are lost by turnings while ploughing an acre on ridges of 274 yards in length, with an 8-inch furrow-slice.* Hence, in ploughing an acre on ridges of 250 yards in length, which is the length of ridge I recommended as the best for horses in draught, when speaking of enclosures (585.), in 10 hours, with a 10-inch furrow-slice, the time lost by turnings is 1 hour 22 minutes. I presume that the experiment alluded to does not include the necessary stoppages for rest to the horses, but which should be included; for however easy the length of ridge may be made for draught, horses cannot go on walking in the plough for 5 hours together (one yoking) without taking occasional rests. Now 250 yards of length of ridge give nearly 4 ridges to the acre, or 36 bouts; and allowing a rest of one minute in every other bout, 18 minutes will have to be added to the 1 hour 22 minutes lost, or very nearly 1¾ hour of loss of time, out of the 10 hours, for turnings and rest. Thus 18,000 yards will be ploughed in 8¼ hours, or at the rate of 1 mile 422 yards per hour. I think this result is near the truth in regard to the ploughing of lea in spring; it is too little in ploughing red land in summer, and perhaps too much in ploughing stubble land in winter; but, as lea-ploughing is the criterion by which all others are estimated, this result may be taken as a near approximation to the truth.

(1149.) The comparative time lost in turning at the ends of long and short ridges may be seen from the following table, constructed from data furnished by the experiment above alluded to:—

Length of ridge.	Breadth of furrow-slice.	Time lost in turning.	Time devoted to ploughing.	Hours of work.
Yards.	Inches.	H. M.	H. M.	H.
78	10	5 11	4 4	10
149	...	2 44	7 16	...
200	...	2 1	7 59	...
212	...	1 56½	8 3½	...
274	...	1 28	8 32	...

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* Sinclair's Code of Agriculture, p. 306.

Thus it appears that a ridge of no more than 78 yards in length requires 5 hours 11 minutes of time to turn at the landings, to plough an acre in 10 hours, with a 10-inch furrow-slice; whereas a ridge of 274 yards in length only requires 1 hour 28 minutes for the same purpose, making a difference of 3 hours 43 minutes in favour of the long ridge in regard to saving of time. Consequently, in the case of the shortest ridge, only 4 hours 49 minutes out of the 10 can be appropriated to ploughing, whereas in that of the long ridge, 8 hours 32 minutes may be devoted to the purpose. Hence so very short ridges require double the time of long ones to plough, and are thus a decided loss to the farmer. This is a subject well worth your experimenting on, by ascertaining the time usually taken in ploughing and turning and resting on ridges of different lengths, in the different seasons, and in different soils. A watch with a good seconds-hand to mark the time will be required, and the observations should be made unknown to the ploughmen, at their usual rate of work; for if you be constantly in the presence of the men, more than the usual work will be done, and less than the usual rests taken.

(1150.) There is another circumstance on some farms which also greatly affect the speed of horses at work, I mean the *great steepness of the ground;* and it is not unusual to see the ridges traversing such steeps straight up and down. Ridges in such a position are laborious to plough, to cart upon, to manure, and for every operation connected with farming. The water runs down the furrows when the land is under the plough, and carries to the bottom of the declivity the finest portion of the soil. In such a position a ridge of 250 yards is much too long to plough without breathing the horses. But although the general rule of making the ridges run N. and S. is the correct one, yet in such a situation as a steep acclivity, they should be made to slope along the face of the hill instead of running right up and down the acclivity, and the slope will not only be easier to labour in every respect, but the soil will be saved being washed so much away in the furrows; but the direction of the slope should not be made at random: it should go away to the right hand in looking up the acclivity, because the plough will then lay the furrow-slice down the hill when it is in the act of climbing the steep, and on coming down the hill the horses will be the better able to lay the slice even against the inclination of the ground. What the exact length of the ridges on such an acclivity should be, even with the assistance of the slope, I cannot positively say, but should imagine that 100 or 150 yards would be sufficient for the horses; but, at all events, there can be no doubt that it would be much better for the labour of the farm, as well as for the soil, that there should be 2 fields 100 yards broad each, one higher up than the other, than that the whole ground should be in one field 200 yards in breadth. I have all along been referring to very steep ascents.

(1151.) There is still another arrangement of ridges which may materially affect the time required to labour them; I mean that where, by reason of irregularities in the fences or surface of the ground, ridges from opposite directions meet in a common line in the same field; and the question is, Whether the ridges should meet in an imaginary line or at a common headridge? Professor Low, when alluding to such an arrangement of ridges, says, that "the part where the opposite sets of furrows meet, may be made an open furrow, *or* a raised up ridge or headland, as circumstances may require." * When ridges meet from opposite directions, it is clear that they cannot be ploughed at the same time without the risk of the horses encountering one another even upon a headridge; and where there is no headridge, should one set of ridges be ploughed before the other, in the ploughing of the second set, the end of the ploughed land of the first will be completely trampled down. At the least, therefore, there should be one headridge betwixt two sets of ridges, that one set may be ploughed before the other. But the most independent way in all respects with such a form of surface, is to treat it as if each set of ridges belonged to separate fields, and let each have a headridge of its own.

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* Low's Elements of Practical Agriculture, p. 156.

(1152.) When *horses are driven in the plough beyond their step*, they draw very unequally together, and, of course, the plough is then held unsteadily. In that case, the plough has a tendency to take too much land; to obviate which the ploughman leans the plough over to the left, in which position it raises a thin broad furrow-slice, and lays it over at too low an angle. On the other hand, when the ploughman allows the horses to move at too slow a pace, he is apt to forget what he is about, and the furrow-slices most probably will then be made both too narrow and too shallow, and though they may be laid over at the proper angle, and the work appear externally well enough executed, yet there will be a want of mould in the ploughed soil.

(1153.) [The whole value of ploughing, scientifically speaking, depends upon its having the effect of loosening the texture of the soil, and thus permitting a free circulation of air and moisture through its interstices, for the double purpose of increasing the rapidity of the disintegration of its stony portions, and of re-reducing to powder what had formerly been pulverised, but which, from the joint action of pressure, and the binding effect of root-fibres, had become agglutinated together.

(1154.) Sufficient has already been said to draw your attention to the point of pulverising the soil; in it lies one of the most important secrets of good farming. However well you may manure your land, however thoroughly you may drain it, you will never obtain the crops it is capable of yielding, unless you pulverise it; nay, so important did Jethro Tull think this, that he felt firmly persuaded that if you pulverised your soil well, you need not manure at all. I need hardly tell you, that we shall prove hereafter Jethro Tull to have carried his conclusions too far; but still so direct and unqualified a statement, from such a writer, should have its full influence upon all who wish to learn thoroughly the art of agriculture. Always bear in mind that the *impalpable powder* is the active part of soil, and that no other portion has any *direct* influence upon vegetation, and you will then, at all times, be sufficiently impressed with the necessity of thorough ploughing, harrowing, &c.; indeed, you may rest assured that, except upon some few very light sands, you cannot pulverise the soil too much—economy alone must fix the limit of this useful operation.

(1155.) But were I to stop here, you might naturally suppose that any season of the year would do equally well for ploughing, provided it was before seed-time, and that the fixing of the time was regulated entirely with a view to economise labour. It is certainly true, that, to a considerable extent, the time of ploughing may be varied; but you may rest assured, that, as a general rule, the sooner you plough after the removal of the crop, the better condition will your soil be in at the commencement of spring.

(1156.) Several chemical processes of considerable consequence as respects the fertility of soil, occur after it has been ploughed, which either take place very slowly, or not at all, while it lies unstirred; and, moreover, some of these take place to the greatest advantage during winter.

(1157.) This is especially the case with the disintegration of mineral masses, nothing tending so powerfully to reduce even the hardest stones to powder as sudden changes of temperature, combined with the presence of much moisture. During rain or thaw after snow all the clods of earth and the pores of the more loosely aggregated stones become filled with water, which, of course, freezes, if the temperature is sufficiently reduced; and from its expansion during solidification (353.) (354.) a peculiar property possessed in a marked degree by water, the particles of earth or stone, as the case may be, are pushed so far asunder, that when the thaw returns, it crumbles into fragments, which are again and again acted on until reduced to the state of soil.

(1158.) This crumbling by frost is of the greatest importance in the case of stiff clays, for two reasons, 1*st*, because they are thus reduced much more easy to work, and, 2*d*, which is of far greater consequence, they are enabled to give up their alkalies more readily to water; and clayey minerals are fortunately the quickest to disintegrate, or rather to *decompose* by the action of the weather; and hence every means that facilitates that process is valuable, because, as we have already seen, that those most valuable ingredients of soil, potass and soda, are of no use to plants, unless they are soluble in water, and that they do not obtain this property until the mineral with which they have been associated becomes completely decomposed.—H. R. M.]

(1159.) [In the previous remarks on the plough were embraced its construction, its principles of action, the principles on which its draught is exerted, and the resistance which it presents to the draught, as also some remarks on the system of ploughing that each of the three leading varieties of ploughs have given rise to; and on this last branch of the subject I feel constrained to offer some further remarks.

(1160.) In treating of the form of the furrow-slice I have sufficiently evinced the preference that I give to the rectangular slice; and this I do on the broad principle that *deep ploughing* ought to be the *rule*, and any other practice the *exception*. The exception may apply in a variety of cases, so well known to practical farmers that it would be presumptuous in me to point them out; but our "Book of the Farm" being peculiarly addressed to young farmers, the pointing out of a few of these cases of exception becomes more in place.

(1161.) Shallow ploughing, then, may be admissible in the case of a field that has been depastured with sheep, and to be simply turned up for a seed-furrow. The reason usually assigned for this is, that the droppings of the sheep forming only a top-dressing, has given rise to the notion that a deep furrow would bury the manure to a depth at which its beneficial effects could not be reached by the plants of the crop that may be sown upon this field. While I allow that this is an admissible case, the *rationale* of the reasons assigned for it, by practical men, may, on very fair grounds, be called in question. Thus, it is well known that the roots of vegetables in general push themselves out in pursuit of their nutriment, and with an instinctive perseverance they will pass over or through media which afford little or no nutriment, in order to reach a medium in which they can luxuriate at will. With the larger vegetable productions this is remarkably the case; and though, amongst those plants which the farmer cultivates, the necessity of hunting, as it were, for food cannot occur to a great extent, yet we are well aware that the roots of the cereal grasses may extend from 6 to 12 or more inches; and there is good reason to believe that their length depends upon the depth of the penetrable soil, and that the luxuriance of growth in the plant will in general be proportioned to that depth, soil and climate being the same.

(1162.) Another case of exception to deep ploughing, is in some of the courses of fallow ploughing, where a deep furrow might be injurious; these occurring in the later courses. And a third is that of a seed-furrow, though in many cases this last is of doubtful recommendation.

(1163.) In some of the clay districts, a system of shallow and narrow ploughing is practised, under the impression that the exposure of the soil, thus cut up in thin slices, tends more to its amelioration than a system of deep and broad ploughing could effect. This supposition may, to a certain extent, be true, as a certain portion of the soil thus treated will undergo a stage of improvement; but allowing that it does so, the improvement is but a half measure. Soils of this kind are frequently deep, and, though apparently poor, they afford the stamina out of which may be formed the best artificial soils—the clay loam—which may be brought about by the due application of manure, and a proper, well-directed, and continued system of ploughing. On lands of this kind, the system of deep ploughing will be always attended with beneficial effects; and instead of the apparently thin and hungry soil which the shallow system is more likely to perpetuate, the result might be a deep and strong clay loam. To effect this, however, there must be no sparing of expense or of labour, the draining must be efficient, and the manuring, especially with those substances that will tend to sharpen and yield porosity to the clay, must be abundantly supplied.

(1164.) The most extensive suite of cases where a departure from the rule is admissible are those lands where a naturally thin soil rests on a subsoil of sand or gravel variously impregnated with oxides of iron. To plough deep at once in such situations would run the risk of serious injury to the sparing quantity of soil naturally existing. But it is to be observed of soils of this kind, that the subsoil has always a tendency to *pan*, and if such do exist, the deep system should again come into requisition in the form of subsoil ploughing, which, by destroying the pan—that frequent cause of sterility in soils of this kind—opens a way to the amelioration of both soil and subsoil.

(1165.) There appears, in short, every reason for inculcating the system of deep ploughing, not only where existing circumstances admit of its adoption, but where its ultimate effects are likely to induce a gradual improvement on the soil and all its products, admitting always that a variation in depth is proper and necessary under the varying circumstances of crops and seasons.

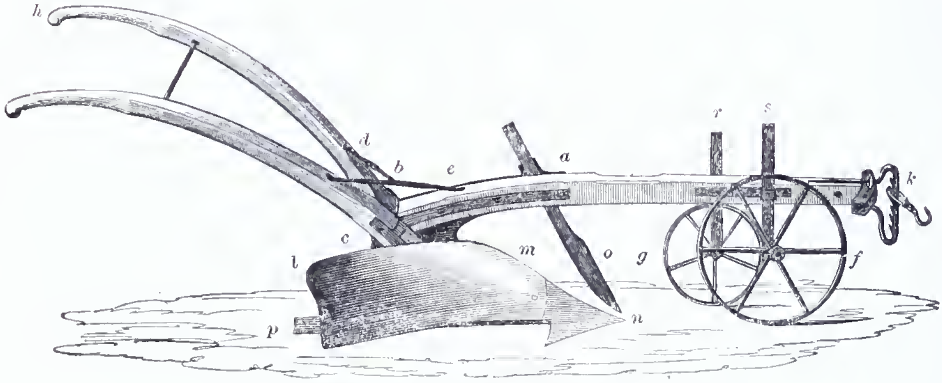
(1166.) Though the Scotch swing plough has afforded the principal subject of what has been here given on this implement, it must not be lost sight of that numerous varieties of this important implement are to be found in other parts of the kingdom, many of which possess a high degree of excellence; and England is especially remarkable for these varieties. It has been already noticed (661.) that the germ of improvement in the Scotch implements appear to have been obtained through England; but, like many other importations from that quarter, the necessities arising from circumstances of climate, of soil, and, perhaps not the least important, the paucity of pecuniary means, obliged the Scottish agriculturist to husband all his resources, and to call forth all his energies, in making the best and most economical use of his new acquisitions, so as in the end to outstrip his more favoured brethren of the south. This will be found to have occurred, not only in the plough, but in the introduction of the turnip, of bone manure, and many other similar acquisitions.

(1167.) It is remarkable, too, that the decided step taken in Scotland in regard to the rapid extension of the use of the improved plough, was long in retracing its steps back to England, and that the retrograde movement was gradual from the northern counties southward. In nearly half a century, this retrogression appears to have made very slow progress; and, like many other improvements which linger until some master-mind takes them in hand, the extension of the use of an improved plough met with little encouragement. In due time, this subject was taken up by the Messrs Ransome of Ipswich, and through their exertions, such changes have been produced in the plough as place the English agriculturist in possession of a command of these implements in such a variety of forms that no other country can boast of from the hands of one maker.

(1168.) The numerous varieties (amounting to at least 100) of the ploughs constructed by the Messrs Ransome, seem to be chiefly adapted to the soils of England, and to the practice of her agriculturists; for we do not find that, when brought into Scotland, and placed in direct competition with the Scotch plough, that they ever gain a preference. There can be no question, however, that some of the varieties of these ploughs perform well, exhibiting work, when conducted by a skilful hand, that for its usefulness may compare with that of any implement now employed. The system of ploughing in England being generally of the shallow character, and the modern plough for the most part of a light construction, adapted to the practice, it has been found that these ploughs were unable to resist the force required where the deep-ploughing system is followed, as in many parts of Scotland. But a more serious objection to the introduction of these ploughs into Scotland lies in the frequent application to them of wheels. No ploughman who has been able to wield the swing plough, will ever suffer himself to be incommoded with the addition of wheels to his plough (for he will always consider wheels an inconvenience), and this he does not from a conviction that wheels increase the labour of his horses, but because to himself they appear a source of annoyance; and here it may be further remarked, as regards wheel-ploughs, that, since the wheels must always have a tendency to increase the draught (810.), and on that account are objectionable, so also, if a plough can be wielded with equal and perhaps better effect without wheels than with them, the excuse that a wheel-plough may be wielded by a man of inferior qualifications is of small value. Any man may be trained to handle a plough, though every man will not be equally successful; and since in the whole of Scotland not a wheel-plough is to be found, except as a curiosity, while her ploughing is at least not inferior to that of any part of the kingdom, and as the chances are surely equal that the ploughmen are not all equally good, it is evident that ploughing can be satisfactorily performed without wheels. If ploughing can thus be performed over one part of the kingdom with an implement of the simplest form, and in a satisfactory and economical manner, there can be no necessity for using a more complicated and more expensive machine to perform the same work in another part of the kingdom, where it is at least not *better* done or done at less expense.

(1169.) Having adverted to the ploughs of England, and particularly to those of the Messrs Ransome, and though still impressed with the opinion that the simple Scotch swing plough is preferable as an implement to the wheel-ploughs in their most improved form, and perhaps even to the *swing* ploughs of England, it is proper to describe generally at least one example out of the many.

Fig. 205.



RANSOME'S F F, OR BEDFORDSHIRE PLOUGH.

(1170.) The example chosen for the purpose of illustration is Ransome's F F or Bedfordshire plough, represented in fig. 205. This plough has attained a high character for its general usefulness, and may be considered as the most perfect of modern English ploughs.

(1171.) Without going into such a minute detail of its parts as has been done in the case of the three leading Scotch ploughs, I cannot avoid giving a short description of it. Like the greater part of modern English ploughs, it is constructed partly of wood and partly of iron. The body is of cast iron, and is ingeniously formed for the attachment of the beam and handles. These are simply bolted to the body, a practice which leaves the parts in possession of their full strength, instead of being weakened by the morticing, as is the case in the joining of the beam and left handle of the Scotch wooden plough. The body-frame rises from the middle of the sole bar to the full height of the upper edge of the beam, and the two are bolted together, the body being applied to the landside of the beam, where its upper edge is seen at *a b*. The landsides of the beam and of the body lie, therefore, in one plane behind; but the beam, at the point, lies 1½ inch to the right of the body-plane. The handles are bolted to a vertical flange that projects from the hind part of the body; and as an additional security to the right handle, a bar of cast iron, extending from *a* to *c*, is laid upon the right hand side of the beam, as seen in the figure, and fixed by the same bolts that connect the beam and the body. The hind part of this bar is also formed to embrace the root of the right handle, and is also secured by bolts. A further security is effected by the application of the iron stay-bar *d e*, tying the beam and handles together. When the landside of the plough is vertical, the left handle *h* stands 10 inches to the left of the line of the land-side, and the width between the handles *h i* is 26 inches. Following the same rule as has been adopted in giving the details of the Scotch ploughs, we have the zero of the FF, figs. 121 and 122, Plate XII., at 27 inches behind the point of the share *n*, and the heel *p*, 11 inches behind the zero. The extremity of the handles is 4 feet 3 inches behind, and the point of the beam 4 feet 5 inches before the zero, making the horizontal length of the plough only

8 feet 8 inches. The height of the handles above the base line is 2 feet 10 inches; the height of the body, at the junction *b* of the beam and handles, is 14 inches; the height of the beam, at the coulter-box, is 17 inches, and at the point 16 inches; these heights being all as measured to the upper edge of the beam. The bridle *k* of this plough is similar to many others of this much-varied member, but differs in the material of which it is composed, being formed of cast-iron. In fig. 148 the plough is represented with two wheels *f* and *g*, which are mounted on stems *r s*; these move vertically in separate boxes, one on each side of the beam, and are held in position by clamp screws. The larger wheel *f* runs in the furrow, and bears against the *land*, thus regulating the landing of the plough, while the wheel *g* runs *upon the land*, and regulates the earthing of the plough.

(1172.) The active parts of the plough are also peculiar. The mould-board *l m* has been already given in detail in Plate XII., figs. 121 and 122; it is only necessary to add, that its form indicates a medium of the convex and concave surfaces, and that its height points out its inapplicability to deep ploughing. The share *n*, as in a large proportion of all ploughs made by the Messrs Ransome, is of cast-iron, but is very judiciously hardened at the point and along the edge of the feather on the lower surface only, which has the effect of throwing all the wear of the metal on the upper surface, thereby keeping the edge sharp below so long as the share lasts. This share has great breadth, being seldom under 7 inches at the broadest part. In the clays and chalky soils of England, the cast-iron share is both convenient and economical, though it is doubtful how they might answer in gravelly and stony soils, especially in the latter. The price of a cast-iron share is about 1s. 2d., and an allowance is made for them when worn out and returned, of about 6d.; their duration may be taken at from 4 to 14 days, depending much on the texture of the soil. The coulter *o* in this plough, as in most others of the class, is fixed in a metal box bolted in the land-side of the beam. The land-side plane of the coulter, therefore, instead of crossing that of the plough's body, as in the Lanarkshire and other Scotch ploughs, is parallel to it, and stands altogether to landward of the land-side plane of the plough from top to bottom, and in some cases forms a small angle from the point landward. The body is frequently left entirely open on the land-side, except in so far as it is covered by the land-side flange of the sole-shoe, which is not more than 2 inches high, and it stands 1½ inch to landward of the body frame, which last arrangement virtually brings the land-side plane of the body and of the fore part of the beam to coincide.

(1173.) Having in a general way described the construction of the framework and the acting parts of this plough, there remains for me to say a few words on the wheels with which it is furnished. I have already (810–812.) adverted to wheels, as they appear to me to affect the draught of ploughs, and have expressed myself in sufficiently distinct language to shew that, in my opinion, they must in all cases be injurious, and tend to increase the resistance of the plough to which they are appended, whether they be applied within the body, or under the front, or any other part of the beam. That wheels may be of advantage for the working of a plough in the hands of an unskilful ploughman may be true; but if this advantage is acquired by a certain additional expenditure of horse power, which, however much the proprietor of the team may blind himself to, will ultimately, though probably unheeded, tell on his profit and loss account, there will be no gain, but an ultimate loss. It must be admitted, even by the advocates of the wheel-plough, that though they may be handled with perfect regularity in ploughing *along* ridges, whether the holder be an experienced ploughman or not, yet in *cross* ploughing they cannot by any means be brought so handily to follow the undulations of the surface. In leaving one ridge, the share will pass too shallow, and in entering on the brow of the next, it will go too deep, or at least deeper than the average of the ploughing. There is also the element of time, which in all farming operations is an important one; and here wheel-ploughs are found to come short by about 25 per cent. as compared with swing-ploughs. Mr Pusey, in his paper on the draught of ploughs, incidentally observes: " While the work of our ploughing teams is at best but ¾ of an acre upon strong ground (and sometimes as much as 1 acre upon the lightest), the daily task performed by two Scotch horses upon strong land is 1¼ acre."* This deficiency of effect cannot be attributed to want of power in the horses, for English horses are at least not inferior to those employed in Scotland for agricultural purposes, neither can it be from unskilfulness in the ploughmen, for even the most skilful seem to come short in this respect, by not being able to plough more than ¾ of an acre in a day, while with the swing-plough almost any ploughman will turn over his acre a-day. From the remarks of the same writer,† it is to be inferred that a Scotch swing-plough was incapable of being drawn through a certain clay soil by two horses, while the wheel-ploughs were found to perform the work with tolerable ease, though still a heavy draught. There may be such cases; but from the conditions of this particular case, where the draught that baffled the horses in the swing-plough seems not to have exceeded 52 stones, there is an ambiguity in the matter that leads to doubts of the accuracy on the part of the observers of the experiment. We know well that in working the Scotch swing-plough in an 8 or 9 inch furrow on stiff land, the draught is not unfrequently as high as 7 cwt. or 56 stones; but two good horses never shrink from the task; and how a less draught, whatever be the soil, should have baffled the exertions of two good horses in a swing-plough, even in the Oxford clay, requires some further investigation to be satisfactory.

(1174.) Under all the circumstances, then, whether we take expenditure of horse power compared with the small saving in the pay of an inferior workman, the disadvantages attending the more complicated operation of ploughing, compared with the celerity with which the swing-plough can be made to accommodate itself to all irregularities of ground; the loss of time, which is equivalent with capital, in ploughing a given surface, when compared with the extent turned over by the swing-plough, and the probability that even the solitary instance of an apparent superiority in a wheel-plough, may rest upon some oversight in observation, all seem to conspire to produce a conviction that a superiority exists in the swing-plough which is in some measure due to its deserving that appellation from an absence of wheels. And certainly, whatever be the merits of the modern improvements on English ploughs, they may be ascribed to any other cause than their possessing wheels, in whatever position they may be placed in the plough.

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* Journal of the Royal Agricultural Society of England, vol. i., p. 239.

† Ibid., vol. i., p. 225.

(1175.) The plough under consideration is furnished with two wheels, see again fig. 205. The land-side wheel is 12 inches diameter, with a rim not exceeding 1 inch in breadth. The only purpose to which this wheel is applied is to regulate the depth of the furrow, for which purpose it runs upon the solid land. The furrow-wheel is 18 inches in diameter, with a breadth of rim equal to the former; its object is twofold, serving in some measure to regulate the depth, by running on the bottom of the previously formed furrow, but its chief duty is, by bearing against the edge of the furrow-slice that is about to be raised, to regulate the *breadth* of the slice, at the desired height, by means of pinching-screws.

(1176.) It is evident that both wheels perform a duty that either of them alone could do with perhaps equal effect, namely, the regulation of the depth; but the furrow-wheel performs a second office, regulating the breadth, which it can also do without interfering with its other duty. It would appear, therefore, that the land-side wheel may be set aside without impairing the efficiency of the plough; and we find, accordingly, that these ploughs are frequently used with only one wheel, which in itself performs both duties.

(1177.) The consideration of these wheels, and their effects on the plough, suggests a further objection to their utility in respect of the increased resistance they produce to the draught. If these wheels are to produce any effect at all, the plough irons and yoke must be set so as to give the plough a bias both to *earth* and *land.* If the plough has not this, then whether it swim evenly, or have a bias, *from* both earth and land, in either case the wheels are ineffective, as they will neither bear upon the sole nor the edge of the furrow, but let the plough have the bias as proposed to both *earth* and *land*, the wheels will then both bear, and exert their efforts by reaction to counteract the tendency of the plough; on the one hand to sink deeper in the furrow, and on the other to cut a broader slice; and since " action and reaction are alike and in opposite directions," these antagonist forces will be in constant operation to a greater or less amount. Such effects will thereby increase the friction and consequent resistance in proportion to the amount of bias which has been given to the plough; and hence the conclusion is strengthened, that in all cases wheels are an incumbrance and a source of increased resistance to the plough.

(1178.) Amongst the numerous makers of ploughs in England whose works have come under our observation, besides those of Messrs Ransome, I cannot omit to notice the names of Hart, of King, of Parker, and of Crosskill, all of whom take a high standing as plough-makers after the English fashions, and many of their productions are mounted with wheels. It is unnecessary to repeat any of the observations on that head, but should the preceding remarks come under the observation of any of the makers referred to, or of any other person who may take an interest in the subject, it will be gratifying to find that they endeavour to shew how wheel-ploughs can be rendered more advantageous than swing-ploughs, and in doing so, either practically or demonstratively, in a satisfactory manner, I shall be open to conviction, and ready to yield up that system which appears to me at present as the only tenable one; but it would, of course, be still more satisfactory to learn that these very humble efforts shall be of any use in satisfying those who take the trouble to inquire, that an extended application of the swing-plough practice might either be of individual or general importance.

(1179.) Amongst the other numerous varieties, I cannot pass over the *two-furrow plough*, which, though seldom, if ever, seen in the hands of a Scotch farmer, is now rather extensively employed in some of the eastern counties of England, but more especially in Lincolnshire. These ploughs are constructed of a very effective and convenient form by Ransome and others, and are held to be very economical in point of draught, a pair of good horses being capable of working a two-furrow plough, or in cases of heavier soil three horses; the saving of labour in the one case being one-half, in the other one-fourth. They are also mounted with wheels, and in the districts where they are employed, and the ploughman accustomed to the implement, they make very fair work, the two furrows being in general laid very nearly alike. It must be conceded, however, that in the districts where these ploughs are used the work is done with a very shallow furrow, seldom exceeding 3 or 4 inches, which may allow of 2 horses taking the draught. Where the deep-ploughing system is followed, a two-furrow-plough could not be drawn by fewer than 4 horses, which, as it would afford no saving, but rather the contrary, can never be expedient, or in any way advantageous; for though it may be urged, that when a light furrow only was required the two-furrow plough might offer some advantage, yet if it could not be applicable in every case, the inference is, that two sets of ploughs, double and single furrow, must be retained—a practice which cannot, under any circumstances, be recommended. The conclusion to be drawn from these remarks is, that though expedients, such as the two-furrow plough, may be very advantageously employed under a particular climate and soil, the practice cannot be held up as one of general application, or that could be rendered economical and advantageous under all circumstances.—J. S.]

(1180.) This seems to me a befitting place to say a few words on *ploughing matches*. I believe it admits of no doubt that, since the institution of ploughing matches throughout the country, the character of our farm-servants as ploughmen has risen to considerable celebrity, not but that individual ploughmen could have been found before the practise of matches existed as dexterous as any of the present day, but the general diffusion of good ploughing must be obvious to every one who has been in the habit of observing the ploughed surface of the country. This improvement is not to be ascribed to the institution of ploughing matches alone, because superior construction of implements, better kept, better matched, and superior race of horses; and superior judgment and taste in field labour in the farmer himself are too important elements in influencing the conduct of ploughmen, to be overlooked in a consideration of this question.

(1181.) But be the primary motive for improvement in the most important branch of field labour as it may, there cannot be a doubt that a properly regulated emulation amongst workmen of any class, proves a strong incentive to the production of superior workmanship, and the more generally the inducement is extended, the improvement arising from it may be expected to be the more generally diffused; and on this account the *plough medals* of the Highland and Agricultural Society of Scotland being open for competition to all parts of Scotland every year, have perhaps excited a spirit of emulation among ploughmen, by rewarding those who excel, beyond any thing to be seen in any other country. Wherever 15 ploughs can be gathered together for competition at any time and place, there the ploughman who obtains the first premium offered by those interested in the exhibition, is entitled to receive, over and above, the Society's plough medal of silver, bearing a suitable inscription, with the gainer's name.

About 40 applications are made for the medals every year, so that at least 600 ploughmen annually compete for them; but the actual number far exceeds that number; as, in many instances, matches comprehend from 40 to 70 ploughs, instead of the minimum number of 15. The matches are usually occasioned by the welcome which his neighbours are desirous of giving an incoming tenant to his farm, and its heartiness is shewn in the extent of the assistance which they give him in ploughing a field or fields at a time when he has not yet collected a working stock sufficient for the purpose.

(1182.) Ploughing matches are generally very fairly conducted in Scotland. They usually take place on lea ground, the ploughing of which is considered the best test of a ploughman's skill, though I hold that drilling is much more difficult to execute correctly. The best part of the field is usually selected for the purpose, if there be such, and the same extent of ground, usually from 2 to 4 ridges, according to the length, is allotted to each portion of ground to be ploughed. A pin, bearing a number, is pushed into the ground at the end of each lot, of which there are as many marked off as there are ploughs entered in competition. Numbers corresponding to those on the pins are drawn by the competing ploughmen, who take possession of the lots as they are drawn. Ample time is allowed to finish the lot, and in this part of the arrangements, I am of opinion that too much time is usually allowed, to the annoyance of the spectators. Although shortness of time in executing the same extent of work is not to be compared to excellency of execution, yet it should enter as an important element into the decision of the question of excellence. Every competitor is obliged to feer his own lot, guide his own horses, and do every other thing connected with the work, such as assorting his horses, and trimming his plough-irons, without the least assistance.

(1183.) The judges, who have been brought from a distance, and have no personal interest in the exhibition, are requested to inspect the ground after all the ploughs have been removed, having been kept away from the scene during the time the ploughs were engaged. Now, this appears to me a very objectionable part of the arrangements, and it is made on the plea, that were the judges to see the ploughs at work, some particular ones might be recognised by them as belonging to friends, and their minds might thereby be biased by the circumstance. Such a plea pays but a poor compliment to the integrity of the judge; and any farmer who accepts of the responsible and honoured office of judge, who would allow himself to be influenced by so pitiful a consideration, would deserve not only not to be employed in a similar arbitration again, but to be scouted out of society. One consequence of the exaction of this rule is, that the spectators evince impatience—the spectators, not the ploughmen who have been competitors, for they are busily and happily occupied at the time in replenishing the inner man with rations of cheese and bread and ale provided to them by the possessor of the field who is to enjoy the profits of their labour—while the judges are taking no more than the proper time for deciding the ploughing of, it may be, a large extent of ground. The judges ought, therefore, to be present during the whole time devoted to the competition, when they could calmly and certainly ascertain the nature and depth of the furrow-slices, and have leisure to mature their thoughts on points which may turn the scale against first impressions. That the bare inspection of the finished surface cannot inform them, in a satisfactory manner, whether the land has been correctly ploughed or not, which can only be done by comparison of the soles of the furrows while the land is ploughing, I shall endeavour to make clear to you by figures in a supposed case.

(1184.) You have seen the action of different ploughs, which may be all employed in the same match; and you have seen that the East Lothian form of plough lays over a slice of one form, as in fig. 108, and that the Lanarkshire plough lays over a slice of another form, as in fig. 109, and paragraph (765.) acquaints you, that the latter form of slice, namely, that with the high crest and serrated furrow sole, contains $\frac{1}{7}$ less earth than the other. Now, were the surface work only to be judged of, which must be the case when judges are prohibited seeing the work done in the course of execution, the serrated extent of the furrow-sole cannot be ascertained by removing portions of the ploughed ground here and there, so well as by constant inspection. As equal ploughing consists in turning over equal portions of soil in the same extent of ground, other things being equal, a comparison of the quantity of earth turned over by these two ploughs may be made in this way. Suppose a space of 1 square yard, turned over by each of the two kinds of ploughs specified, taking a furrow-slice in both cases of 10 inches in breadth and 7 inches in depth, and taking the specific gravity of soil at 2.7, the weight of earth turned over by the East Lothian plough would be 63 stones, while the Lanarkshire plough would only turn over 54 stones, making a difference of 9 stones of 14 lb. in the small area of one square yard. In these circumstances, is it fair to say, that the horses yoked to the East Lothian plough have done no more work than those yoked to the Lanarkshire, or that the crop for which the land has been ploughed will receive the same quantity of loosened mould to grow in in both these cases? The prohibitory rule against the judges making their inspection during the ploughing has been relaxed in several instances; but I fear more from the circumstance of the spectators losing their patience, while waiting for the decision after the excitement of the competition is over, than from regard to the justness of the principle. Thus far is the obvious view of the question regarding the mode in which ploughing-matches is usually conducted; but in what follows will be found a more important view as affecting the integrity of good ploughing.

(1185.) [The primary objects of the institution of ploughing matches must have been to produce the best examples of ploughmanship—and by the best, must be understood that kind of ploughing which shall not only *appear* to be well done, but must be thoroughly and essentially well done. In other words, the award should be given to the plough that produces not only work of a proper surface finish, but which will exhibit, along with the first, the property of having turned up the greatest quantity of soil and in the best manner. That this combination of qualities has ceased to be the object of reward, is now sufficiently apparent to any one that will examine for himself the productions and rewards of recent ploughing matches, and the causes of such dereliction is this:—

(1186.) The introduction by Wilkie of the Lanarkshire plough, gave rise, as is supposed, to the high-crested furrow-slice. It cannot be denied that the ploughs made on that principle produce work on lea land that is highly satisfactory to the eye of a ploughman, or to any person, indeed, whose eye can appreciate regularity of form; and, as there are many minds who can dwell with pleasure on the beauty of form, but who do not combine with that idea its adaptation to usefulness, it is no wonder that ploughs which could thus affect the mind through the sense of sight, should become favourites. While the crested system of ploughing kept within bounds, it was all very good, but in course of time, the taste for this practice became excessive; and losing sight of the useful, a depraved taste, of its kind, sacrificed utility to the beautiful, in so far as ploughing can be said to produce that impression. This taste came gradually to spread itself over certain districts, and plough-makers came to vie with each other in producing machines that should excel in that particular point of cresting. A keen spirit of emulation amongst ploughmen kept up the taste amongst their own class, and very frequently the sons of farmers became successful competitors in the matches, which circumstance gave the taste a higher step in the social scale. Thus, by degrees, the taste for this mode of ploughing spread wider and wider, until, in certain districts, it came to pervade all classes of agriculturists. At ploughing matches in those districts, the criterion of good ploughing became generally to be taken entirely from the appearance of the surface; furrow-slices, possessing the highest degree of parallelism, *exposing* faces of equal breadth, and, above all, a high crest, carried off the palm of victory. I have seen a quorum of plough judges " plodding their weary way" for two hours together over a field, measuring the breadth of faces, and scanning the parallelism of slices, but who never seemed to consider the underground work of any importance, in enabling them to come to a decision. Under such a system, it is not surprising that ploughmen devote their energies to produce work that might satisfy this depraved taste, and that plough-makers find it their interest to minister to those desires, by going more and more into that construction of parts of the plough that would yield the so much desired results. Thus have those valuable institutions of ploughing-matches, in the districts alluded to, been unwittingly brought to engender a practice which, though beautiful as an object of sight, and when within due bounds, also of utility, has induced a deterioration in the really useful effects of the plough.

(1187.) But it is not yet too late to retrieve what has been lost. Let the Highland and Agricultural Society of Scotland, and all local agricultural associations, take up the subject, and institute a code of rules by which the judges of ploughing matches shall be guided in delivering their awards. Let these rules direct attention to what is truly beneficial to the land, as well as what may be satisfactory to sight in ploughing. When such rules shall have been promulgated from competent authority, we may hope to see ploughing-matches restored to their pristine integrity—doing good to all who are concerned in them, and resting that confidence in their usefulness which is at present on the wane, but distrust in which has only arisen from an accidental misdirection of their main objects.

(1188.) In connection with that part of the subject which has given rise to the foregoing remarks on ploughing matches, it is not a little curious to find, that instead of the high-crested furrow being a modern innovation, it is as old as the days of Blith in 1652; and he, like the moderns, had entertained the same false notions of its advantages. In his curious work under the section, " How to plough as it may yeeld most mould," he, in his quaint style says— " As for your ordinary seasons of ploughing, your land being in good tillage, any well ordered and truly compassed plough will do, you may help yourself sufficiently in the making of your irons, if you would have the edge of your lying furrow lye up higher, which will yeeld most mould, then set your sharephin the shallower, and set your plough the broader, and hold it the more ashore, the plough-man going upon the land, and it will lay it with a sharp edge, which is a gallant posture for almost any land, especially for the lay turf beyond compare."*

(1189.) The setting of the share-phin (feather) as here described, is precisely what is done in the modern ploughs to make them produce the high-crested furrow (764.) Blith seems to consider that holding the plough "ashore" (to landward), aids the effect; it will make a slice thinner at one edge, but not more acute in the crest.—J. S.]

30. OF TRENCH AND SUBSOIL-PLOUGHING, AND OF MOOR-BAND PAN.

> "If deep you wish to go, or if the soil
> Be stiff and hard, or not yet cleared of stones,
> The Scottish plough, drawn by a team four strong,
> Your purpose best will suit;———"
>
> GRAHAM.

(1190.) Trenching of land with the spade has been a favourite operation in gardening for many ages; and since the plough became the substitute for the spade in field culture, it has been employed for the same purpose, of deepening the friable portion of the soil, and affording to the roots of plants a wider range in which to search for food. It is highly probable, however, that the plough could not have closely imitated the trenching of ground with the spade until after the introduction of the mould-board, which, comparatively speaking, is of very recent date, the ancient plough retaining its primitive simplicity of form until within a few centuries. Indeed, until the mould-board was added, it was scarcely in the power of the plough to trench the soil, that is, to reverse the position of the furrow-slice and mix the upper and lower soils together. When it was added, may now be difficult to ascertain; but fully two centuries ago, Hartlib, in his Legacie, intimates the practice of very deep ploughing, with the mould-board in use, when he says, "There is an ingenious yeoman in Kent who hath two ploughs fastened together very finely, by the which he plougheth two furrows at once, *one under the other*, and so stirreth up the land 12 or 14 inches deep, which in deep land is good." This is essentially trench-ploughing.

(1191.) Within a very recent date, it has been recommended to plough land as deep as trenching, but so as to retain the stirred soil below the surface. Mr Smith, Deanston, by the invention of his subsoil plough, has been the means of directing the attention of agriculturists to this peculiar and apparently new process, which has obtained the appellation of *sub*soil ploughing. A figure and description of his *subsoil plough* is given below. After the introduction of the mould-board subsoil ploughing could not have been practised; but prior to that improvement it is not improbable that the process was known and practised, and so long ago even as by the Romans. It is uncertain what was the depth of the furrow usually made by the Roman plough, some commentators supposing, from a particular phrase used by Pliny, that it was as much as 9 inches, but at all events he designates a depth of furrow of 3 inches as a mere scarification of the soil. There is no doubt, however, from a passage of Columella, that the Roman farmers occasionally gave a deep furrow to good deep land, when he says, "Nor ought we to content ourselves with viewing the surface, but the *quality of the matter below* should be diligently inquired into, whether or no it is of earth. It is sufficient for corn if the land is equally good 2 feet deep." If they imagined that corn received benefit from the soil at the distance of 2 feet below the surface, they would consider it as an advantage to plough as deep as their cattle were capable of, and their plough could go.* As the Roman plough had no mould-board, any *deep* ploughing effected by it would partake much more of the character of a subsoil than of a trench ploughing.

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* Blith's Improver Improved, p. 216, edition 1652.

(1192.) The effect of subsoil ploughing being merely to stir the subsoil without affecting its relative position, the best way of performing the operation is, as I conceive, in the following manner; and it may be executed either in winter or in summer according as it is made to form a part of the spring or summer's operations. It is best executed *across the ridges;* let, therefore, a feering of 30 yards in width be taken across them with the common plough from the upper fence of the field; and this is most easily effected by opening out feering furrow-slices parallel with and close to the fence, if it be straight, and another at 30 paces distant, and let the subsoil-plough follow in both the open feerings. The plough then closes the feerings, and so ploughs from one feering to another until the open furrow is formed in the middle of the feered space between them, followed implicitly all the time by the subsoil plough, which is held by one man, and the horses are driven by another. Feering after feering is thus made and ploughed with the common plough, and followed by the subsoil until the whole field is gone over, with the exception of about the breadth of a ridge at each side of the field, upon which the horses had turned, and the neglect of which is probably of no great importance. Fig. 206 is given as a representation of the operation, where the ploughs and horses appear in black, and where the common plough with 2 horses precedes the subsoil one with 4. The depth taken by the plough is the usual one of 7 inches in stubble, which is seen as the upper furrow, succeeded by the subsoil-plough, which takes usually 9 inches in such a position, and whose furrow is seen in section below that of the other plough, making both furrows 16 inches deep. Care should be specially taken not to allow the subsoil plough to approach within 2 inches of the covering of any drain, otherwise the drain will be torn up and materially injured. The drains in the figure are supposed to be 36 inches deep, filled 12 inches with tile and sole and small stones, and placed in every open furrow at 15 feet as under, the curved form of the ground between them representing the ridges. This figure is not meant to give the exactly relative proportions of the different objects composing it.

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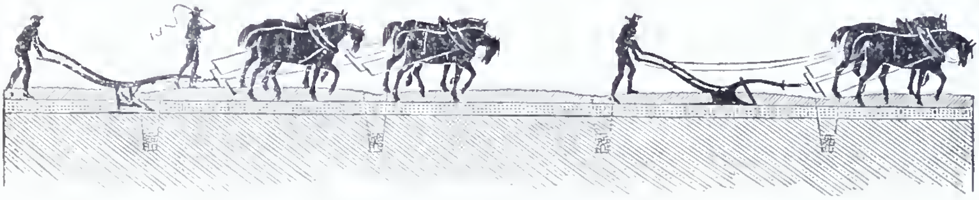
* Dickson's Husbandry of the Ancients, vol. i. p. 442.

Fig. 206.



THE TRENCH OR SUBSOIL PLOUGHING.

(1193.) The immediate effect of subsoil ploughing being to deepen the friable portion of the soil, it is evident that where the subsoil ploughed soil rests upon impervious or even retentive matter, that the operation will increase the depth, and, of course, the capacity of the soil for holding water, and on this account, in so far as respects itself, the operation after wet weather, would do more injury than good to the crops growing upon it. This is a very important fact in regard to the effects of subsoil ploughing, considered in itself, and demands your serious consideration, because a misconception and disbelief of it continues to exist in some parts of the country, especially in England, and injury may thereby be inflicted on land which will require a considerable time to recover. But if injurious effects accompany subsoil ploughing, when it occasions excess of water, it is evident that were drains formed to give the water an opportunity to escape, it would do no injury to plough land to any depth. The misconception which I have alluded to as existing may not be easily dispelled, as the unusual depth to which subsoil ploughing is executed operates in the first instance as a drier of the *surface* of the ground, even when there has been no previous draining, and it also renders drained ground drier; and these immediate effects are regarded by improvers of land as all that are required to be effected by the operation, and, consequently, when it is easily ascertained that subsoil ploughing is a much cheaper operation than draining, and seems to be equally efficacious, they are content to abide by it alone. I have no doubt that much of the land that has been subsoil ploughed in England has been so in consequence of the adoption of this opinion by farmers, upon whose attention the great comparative economy attending the process was so earnestly pressed some years ago by people of influence. They, however, who understood the nature and capability of subsoil ploughing, and Mr Smith himself at their head, both published and publicly stated, that to employ the subsoil plough upon land having a retentive subsoil, without draining it in the first instance, would only aggravate the evil they wished to avoid. It is true that the subsoil plough might penetrate through the retentive matter to an open substratum through which the water would escape; but the chance of meeting with such a rare arrangement of strata, forming the exception to the general structure of clayey subsoil, cannot afford a sufficient excuse for an indiscriminate use of the subsoil plough.

(1194.) It should therefore be laid down as a general rule, that no land ought to be subsoil-ploughed unless it has been previously drained, for where the subsoil is so porous naturally as not to require draining, neither will it require subsoil ploughing. After being thoroughly drained, any sort of land may be subsoil-ploughed with safety, that is, no harm will accrue from it, but all sorts of land will not derive equal advantage from the operation. Taking it, therefore, for granted, that draining should precede the subsoil plough, the interesting inquiry arises, in what quality of subsoil does subsoil ploughing confer the greatest (if any) benefit to land? the correct answer to which can alone determine the extent to which this operation should be carried. In the first place, in pure plastic clay, any opening made by the subsoil plough passing through it would probably soon collapse together behind the implement. Through such a clay, in a dry state, the operation would be performed with great difficulty, if not prove impracticable. In what is usually called *till*, that is, clay containing sand veins, small stones, or small boulders, the subsoil plough will pass sufficiently well, though slowly, and it will displace even pretty large stones, and the clay be afterwards kept open for a time. Hardened masses of gravelly clay may be entirely broken up by this operation. I believe experience has established the effect of the subsoil plough in these respects. It thus appears that the sphere of the subsoil plough, as an operation of permanent utility, is limited to the breaking up of hard gravelly subsoils; because it is scarcely supposable that it can keep pure clay always open, and it certainly admits of doubt that it will keep a tilly bottom constantly open, as experience has proved, that percolation of water through a somewhat porous clay, renders it more firm, by the well-known fact that such a soil, returned above a drain, soon becomes as firm as any other part of the field. Hard, chalky, gravelly matter, and moorband-pan are the only subsoils on which one would feel confident that subsoil ploughing would confer permanent benefit. I say *permanent* benefit; for I believe it is acknowledged that the process confers an immediate benefit in almost every case in which it has been tried; and on this account, its keener advocates have claimed for it much, if not the entire, advantages derived from its precursor—thorough-draining; and there seems some ground for the claim, inasmuch as subsoil ploughing is executed so soon after thorough-draining that it would be impossible to assert the superior claims of draining, were it not for its occurrence being more common without than with subsoil ploughing; whereas, when the latter is taken by itself, it cuts but a sorry figure. In vindication of his own invention, Mr Smith endeavours to explain in general terms *why* indurated subsoil, when drained, should preserve the friability imparted to it by subsoil ploughing. "When drains have been some time executed," he says, "innumerable small fissures will be found in the subsoil, extending from drain to drain; these are caused by the contraction of the substance of the soil arising from its drier state. The contraction being greatest in the stiffest clays, the operation of the subsoil plough admitting the air to a greater depth, the fissures take place under its operations, and generally reach to the level of the bottom of the drains." This is a natural enough explanation of the almost immediate effect of draining wet subsoils. and also of the almost immediate extension of its effects by a subsequent subsoil ploughing. "These fissures," he continues, "will get more or less silted or glutted up, from time to time, by the minute alluvial particles carried down and left in filtration by the rain-water," which is also a natural effect; but he adds, "the constant expansion and contraction of the unremoved subsoil, by the alternations of wet and dry, has a perpetual tendency to renew them;" and it is this effect which I question, because, before such expansion and contraction can be kept up, it must be assumed that the subsoil, after being subsoil ploughed, has no tendency to consolidate into its original state, whether of strong clay or any other substance; and yet the conviction, as I conceive, of all drainers must be, that every sort of subsoil, except hard rock, consolidates, however well it may have been stirred, though perhaps not to the degree of impermeability it may have possessed before; but, at all events, the more friable it becomes in its condition, it will be the less affected by the "alternations of wet and dry." *

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* Smith's Remarks on Thorough-Draining, p. 25.

(1195.) It is allowed by all who have used the subsoil plough, that it requires much greater exertion from the horses to work it than the common plough; and that horses do not work well together in it for some time. With regard to the quantity of ground which a plough will subsoil in a day, in a long day in summer, 1 imperial acre may be calculated on being accomplished in favourable circumstances; but should obstructions occur, such as large boulder stones, ¾ of an acre is a very good day's work; and in winter ¾ is a good day's work without obstructions.

(1196.) The great force required to work even the lightest of the Deanston subsoil ploughs, which weighs 18½ stones, the heaviest weighing 28½ stones of 14 lb., and the insuperable bar which this circumstance places against its employment on farms working less than 3 pairs of horses, have induced people to contrive what they designate subsoil ploughs to be used as a substitute for the Deanston one; but in every modification which I have seen proposed, their effect is quite different from what Mr Smith proposes that his should produce. The Deanston subsoil plough not only penetrates the subsoil to a determinate depth, but by the simple contrivance of the feather, the subsoil is not only stirred, but pushed a little aside, and thereby partially mixed with the portion adjoining it. In doing this there is little doubt that it is the action of the feather which causes the principal weight of the draught complained of in this plough. To avoid this redundancy of draught, as it is supposed to be, a feather is discarded, and simply a large tine bent forward at the point, as in the case of Gabell's subsoil plough,* or a small scarifier, as in the case of the Charlbury one,† is substituted as its principal feature, a furrow being opened by the common plough preceding, as in the case of the subsoil one. But as the subsoil plough makes a demand on the horses of the farm for a common plough as well as itself, it is proposed in the Charlbury one, to have a small plough attached to the beam to lay over the furrow slice, in order to prepare it for the tine or scarifier to pass along. But although a lightness of draught has been attained in both these instances, and a pair of horses have been said to be able to work Gabell's to the depth of 18 inches, it requires 4 horses to work the Charlbury to 12 inches, which as a saving of labour is of no great importance, except as regards the employment of the common plough in preparing the way; for the difference in the nature of the work performed by them differs so widely from that of the Deanston plough, that they cannot be said to be its substitutes, inasmuch as they only make ruts in the subsoil at the distance of the breadth of a furrow-slice from one another, namely, 8 inches at the least, most probably 9 inches, and not improbably 10 inches, and which of course leave ribs of hard land standing untouched in the subsoil. It is acknowledged by the proposers of these substitutes, that the Deanston is more efficient than either; and as Mr Smith's opinion is that the heaviest of his ploughs does the most satisfactory work, it is clear that they can never be a substitute for his, provided he is correct in his views regarding the utility of *thorough* subsoil ploughing, which these substitutes certainly do not even profess to perform. The conclusion I would draw from the inefficiency of these modifications and substitutes for the Deanston subsoil plough is, that none of them are likely to be used on farms employing less than 3 pairs of horses, such employment being the only object their contrivers had in offering them to public notice.

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* Journal of the Royal Agricultural Society of England, vol. ii. p. 421.

† Ibid. vol. i. p. 434.

(1197). A modification has been proposed and practised in the use of Mr Smith's own subsoil plough, which is, that instead of passing it in every furrow of the preceding small plough, it should pass in every other furrow. The advantages said to be derived from this plan are, that it is cheaper, speedier, and the subsoil is not so much broken, though broken enough to allow the water to escape to the drains; but it is obvious that it is this very defective mode of operation which constitute the great objection to the English substitution of the Deanston plough.

(1198.) Instances are not awanting to prove that benefits have been derived from the conjoint operations of thorough-draining and subsoil-ploughing,[*] but as in almost every recorded case, the combined effects of both operations are reported, it is impossible to ascertain the advantages derived from each. In a memorandum which I made some time ago, but now forget where the circumstance happened, I find it stated, that a field of lea was drained in 1838, and the crop of oats from it in 1839 did not exceed 13 bushels per acre imperial; whereas, after it was subsoil-ploughed, another crop of oats in 1840 gave 32 bushels per acre. It is well understood that the first crop of oats from lea newly thorough-drained never yields an increase; but in this instance, I have no doubt that the second crop of oats would have been better than the first, without the use of the subsoil-plough, especially if the lea were old. In Mr Laing's experience on Campend, Mid-Lothian, he has "found land to be more thoroughly dried after subsoil-ploughing (especially when there was any approach to clay in the subsoil), with a drain in every alternate furrow, than with a drain in every furrow without it; in fact, on a stiff clay subsoil I have seen drains of little service, the water for some time standing on the top of them till evaporated, while in the very next field which had been subsoil-ploughed, there was an immense flow of water in every drain, and not a drop to be seen on the surface." Such an effect is not at all surprising, as it is well understood that subsoil-ploughing greatly assists thorough-draining at first in drying land, and that effect appears the more striking, when the land has not been so well drained as it should have been, which it certainly would not be, with a drain in every alternate furrow, when it is so strong as that mentioned by Mr Laing; where he says of a field of 10 acres that was subsoil-ploughed in November 1836, a wet season certainly, that it "was at the time, and during the whole operation, so saturated with rain, that the horses' feet sunk in the unploughed ground from 4 to 6 inches, which shewed, though there was a drain in every alternate furrow, they had not drawn the water from the stiff retentive subsoil. This circumstance," continues Mr Laing, "convinced me the more of the necessity of persevering in subsoil-ploughing, which *alone* enabled me to accomplish my object of thoroughly drying the soil."* The conclusion come to is scarcely a fair inference from the premises, which should rather, in the first instance, have brought conviction, from the nature and wet state of the soil, of the necessity of persevering in thorough-draining, by making a drain in every, instead of every alternate, furrow; and it was after *thorough*-draining had failed, that the drainer would be entitled to say, "that subsoil-ploughing *is an indispensable* accompaniment to furrow-draining," "or that *it alone* enabled him to accomplish his object of thoroughly drying the soil." I cannot refrain from making a passing remark here, that there is a strong propensity in farmers generally to laud the good properties of its auxiliaries at the expense of thorough-draining, and I can only account for the prevalence of the feeling, from the *fact* being well known to them, that it is *cheaper* to subsoil-plough land than to thorough-drain it, the amount of labour to put it in the condition of being thoroughly dry, depending upon its nature.

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[*] Journal of the Royal Agricultural Society of England. vol. i. p. 29, 33, 38; vol. ii. p. 316; vol. iii. p. 18.

(1199.) Mr Melvin, Ratho Mains, Mid-Lothian, says what will readily be believed in Scotland, that "I have never seen *any* benefit from the use of the subsoil plough upon damp-bottomed land that had not been drained;" and after a fair trial in a particular field of deep, soft, damp soil, of both operations conjointly, he expresses himself in terms which places the art of subsoil ploughing in nearly its proper position. "Much, no doubt, of the improvement in the condition of this field, is to be attributed to draining, still, the quick absorption of the water in the furrows between the drains (the land being cast), the decided improvement of the drier part, and the uniformly equal crop, sufficiently attest the merits of subsoil ploughing." I have said that, in these remarks, Mr Melvin has placed subsoil ploughing in *nearly*, but as I conceive, not altogether its proper position; because the field was drained in the alternate furrows, and the drier part of it was not drained at all. Now, had every furrow been drained, would not the water have been quickly absorbed; and had the drier part been drained, would it have required subsoil ploughing at all?

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* Prize Essays of the Highland and Agricultural Society, vol. xii, p. 514.

(1200.) With regard to the expense of subsoil ploughing, it may be fairly taken at the cost of 3 pairs of horses and 3 men, and wear and tear of implements per day for every ¾ of an acre imperial ploughed; and Mr Pusey instances a case of a farm of not 600 acres of cold clay, the subsoil ploughing of which was estimated to cost L.1300, but how this sum was made out does not appear.* The returns of grain crops seem to imply an increase of 25 per cent. at most, and in regard to green crops, an instance is given of a yield of turnips off peaty soil, resting on stiff clay and hard sand and gravel at Drayton in Staffordshire, belonging to Sir Robert Peel, of "four times the quantity in weight ever produced in the same field at any previous time," the large crop alluded to being 27 tons per acre including tops.†

(1201.) With regard to *trenching* the ground, it has long been practised by gardeners with the spade, and its object is to bury the exhausted soil on the surface with all its seeds of weeds and eggs of insects, and bring up to the surface a comparatively fresh and unexhausted soil, not so rich with manure as the one buried down, but more capable, by its fresh properties, to make a better use of the manure put into it. Trenching with the spade is also practised on farms on a large scale. From experience in both ways, I can maintain that it is cheaper to trench rough stony ground with the spade than with the plough, giving consideration to the state of the soil when left by the two implements. The plough with 4 horses will turn over and rip up a strong furrow, and where there are no stones and roots, it will answer the purpose well enough; but where stones, though small but numerous, and if large, are encountered, the furrow becomes very uneven and unequal, the horses jaded, the men fatigued, the implement broken, and the work very imperfectly done. It is the same case with the roots of trees, and even of bushes, against which, when the plough comes, horses pull with vehemence, so as either to injure themselves, or break their tackling. At such work, I had two valuable horses so much injured in their wind, as to become unfit for ordinary farm work; and finding so I abandoned the plough for this purpose altogether. The same work, on the other hand, can be much better done with the spade, and when it is undertaken by a contractor who remains constantly with the spadesmen, it will be your own fault in superintendence, if the work be ill executed.

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* Journal of the Royal Agricultural Society of England, vol. i. p. 433.

† Ibid. vol. iii. p. 21.

(1202.) I have found this plan succeed in making good trenching. Let the ground to be trenched be laid off in lots with pins; and let the lots contain equal areas of five yards in breadth. The trench to be 14 inches in perpendicular depth in the solid ground on the average over the lot, the surface being left even with the general inclination of the field that is to be. The 14 inches out of the solid will give a depth of 16 inches in the trenched part of the ground. The contractors should be obliged to remove all stones, large and small, all roots, large and small, and every other thing that is likely to obstruct the future course of the plough, and lay them upon the surface of the trenched ground; and should large boulders be found a little below the surface, these must either be blown to pieces by gunpowder, and the fragments left on the surface, or further sunk in the earth so as to be out of the reach of the plough in future, according as you find that you may have use for the stones for drains or foundations of fence dykes. The trenching is begun at the utmost limit of the rough ground, by each man rutting some breadths of 12 or 15 inches wide across his lot, and making a trench of the required depth of 14 inches, gauged by a stick kept constantly in his possession to guide him in the depth, that he may not have the plea of ignorance to urge in extenuation of his cupidity. The upper turf or spading is put on its back in the bottom of the trench; the soil is then dug and thrown upon it, care being taken to make the new ground level and even; and, lastly, shovelling the loose earth over the surface, and leaving no inequalities in the bottom of the new trench. After one set of allotted spaces have been trenched in this way, another is ready marked off by the contractor for the men to enter upon as they finish their lots, and the second set should be marked off either along one end or one side of the field, whichever is found most convenient for the future operations of removing the trenched-up materials to their destination, that a whole piece of ground may be cleared for future operations without interfering with the progress of the trenching, the workmen employed in which should be called upon to do nothing else than their appointed tasks.

(1203.) Ground that has lain in this rough state for years will no doubt require draining, and should be drained before or after being trenched, according to circumstances. It should be examined beforehand, by pits sunk here and there, whether the subsoil will afford a sufficient quantity of stones to thorough-drain the ground. If it is supposed or certain that it will, the ground should first be trenched to obtain the stones, and they being on the spot, the drains will be easily filled with them. If the stones be only to that amount as to form an ordinary covering to tiles, then tiles and soles should be used as the principal materials, and, in this case as well as the other, the ground should first be trenched. But if stones are plentiful near at hand, though not in the particular field under improvement, from a quarry hard by for instance, then the drains should be opened and filled to the requisite depth before the surface of the old ground is broken up, that the cartage of the stones may first be borne by it; and the trenchers in that case should be obliged to cover the stones of the drains with turf, and level the ground over them as they proceed with the trenching.

(1204.) The expense of trenching rough ground at 14 inches deep—and it should never be shallower, in order to insure a good plough-furrow ever after—is from 10d. to 1s. per pole, according to the roughness of the ground. I have had very rough ground, consisting of large roots of trees in a scattered wood, with brushwood of birch, alder, whin, and broom, and containing as many stones as would have half-drained the ground, trenched 14 inches deep for 1s. per fall, Scotch measure, which is equal to L.6 : 13 : 3 the imperial acre, or rather more than 9½d. per pole, a large sum undoubtedly, independent of draining, clearing away rubbish, and other horse and manual labour; but then the ground was rendered at once from a state of wilderness to one in which manure could be applied and covered in with an ordinary furrow-slice of mould. If this is not the *cheapest* mode, in a pecuniary point of view, of rendering ground available to cultivation, it is at all events the most pleasant to the feelings in the doing, and the most satisfactory when done.

(1205.) But there is a mode of trenching ground which is best done with the plough, its object being to imitate the work of the spade by descending deeper than the ordinary depth of furrow, and of commixing part of the subsoil with the surface soil, which has been probably rendered effete by overcropping. Ground can be trenched with the plough in two ways, either with a large sized common plough drawn by 4 horses in one of the ways pointed out before, fig. 202, or with one plough going before and turning over an ordinary furrow-slice, and another following in the same furrow drawn by 2 or more, usually with 3 horses, or both ploughs drawn by 3 horses each. It is best performed across the ridges. In either of the above ways the same effect is produced in similar soil, breaking up indurated gravel, deepening thin clays, ameliorating stiff clays by exposure to the air, and mixing old and new soils together, the ultimate effect on all being to *deepen* that portion of the soil which is used by the cultivated crops.

(1206.) In one respect trenching has the same effect as subsoil ploughing, namely, the stirring of the ground to the same depth, the first plough turning over a furrow of 7 inches in depth, and the second going 8 or 9 inches deeper, making in all a furrow of 15 or 16 inches in depth; but in another respect the two operations leave the soil in very different states—the subsoil plough stirs the soil to the depth named, but brings none of it to the surface, whilst the trench plough does not altogether bring that which was undermost to the surface, but commixes the under and upper soils together. This latter practice has long been known in the midland counties of England, but the former has only been presented to the notice of the Scottish agriculturist since 1829.

(1207.) It has been made a question, which is the better mode, if both are not alike, of making the soil fertile?—the advocates of subsoil ploughing alleging that it is better to ameliorate the subsoil while under the soil by the admission to it of air and moisture; while those of the trench plough answer, that if the object of both operations is to ameliorate the subsoil, it will become sooner so by being brought to the surface, in contact with atmospheric air and moisture. But, say the promoters of subsoil ploughing, there are subsoils of so pernicious a nature, having the salts of iron and of magnesia in them, that the upper soil would be much injured by its admixture with such substances. No doubt, answer the trench ploughers, if the subsoil that contained these noxious ingredients in a large proportion were brought up in quantity, when compared with the bulk of the upper soil, injury would be done to it for a time, but they say it is not the abuse but the proper use of trench ploughing which they advocate; and of *such a subsoil,* they would use the discretion to bring up only a little at a time, which they have it in their power to do, until they accomplish their end, namely, that of ameliorating the whole depth of subsoil. But they maintain, that by far the greatest proportion of subsoils do not contain those noxious ingredients; and, besides, the very best and quickest way of getting rid of even these is to bring them at once to the surface, for any of the acids, or the salts of iron, are easily neutralized by the action of lime, which is always applied to the surface; and those of magnesia are most easily reduced on free exposure to the air. And, moreover, they ask, If subsoils shall be ameliorated by air and moisture when stirred by a subsoil, why should they not also be ameliorated when stirred by a trench plough? And they urge further, that trenching may be practised more safely without previous thorough-draining, than subsoil ploughing.

(1208.) I have no hesitation in expressing my preference of trench to subsoil ploughing; and I cannot see a single instance, with the sole exception of turning up a very bad subsoil in large quantity, there is any advantage attending subsoil, that cannot be enjoyed by trench ploughing; and for this single drawback of a very bad subsoil, trenching has the advantage of being performed in perfect safety, where subsoil ploughing could not be, without previous draining. Mr Melvin, Ratho Mains, mentions an instance of a field containing both damp and dry ground, the dry was trench-ploughed in the autumn of 1836, an inch or two of the sandy gravel being brought up, and "was decidedly increased in fertility," both in the turnip and barley crops which followed.* I trench-ploughed a field of 25 acres of deep black mould which had been worn out, with a 4-horse plough, taking and clearing a furrow from 14 to 16 inches deep in the solid land, and bringing up almost in every part a portion of the tilly subsoil, which was only drained to the extent of a few roods put in the face of a slope exhibiting spouts of water. The turnips that followed were excellent; the barley yielded upwards of 50 bushels per acre imperial, and the year after a part was measured off and fenced, containing 6 acres, to stand for hay, which yielded of good hay 1999 stones of 22 lb. Another field, the year after, that was not drained, suffered injury after trench ploughing; but that was in consequence of having been caught with a premature fall of rain in the autumn before the trenched land could be ridged up, and it lay in the trenched furrow al winter. It is stated that Mr Scott, Craiglockart, Mid-Lothian, "trench-ploughed, in the winter of 1833–4, with one common plough following another, a field of 20 acres, every two alternate ridges, and he has never observed on any of the crops the slightest difference."† This is, as I conceive, an unsatisfactory mode of testing the value of any sort of ploughing land, as it is possible that the untrenched ridges derived a certain, and it might be a sufficient, advantage, in regard to drying, from the adjoining trenched ridges.

(1209.) But whilst giving a preference to trench-ploughing over subsoil, I am of opinion that it should not be generally attempted under any circumstances, however favourable, without previous thorough-draining, any more than subsoil-ploughing, but when so drained there is no mode of management, in my opinion, that will render land so soon amenable to the means of putting it in a high degree of fertility as trench-ploughing. Mr Smith himself acknowledges the necessity of trench-ploughing land in a rotation or so after the subsoil has been subsoil-ploughed, in order to insure to it the greatest degree of fertility.‡ The experience in trench-ploughing after thorough-draining of the Marquis of Tweeddale at Yester, East Lothian, may with great confidence be adduced in favour of the system. I have seen a field on Yester farm under the operation of draining which did not carry a single useful pasture plant, but which afterwards admitted of the turnips being drilled across the face of inclining ground, and of presenting to sheep in winter as dry a bed as they could desire; and no farther gone than the spring of 1841, after the Swedish turnip seed had been sown, a field was trench-ploughed with 3 powerful horses in each plough, bringing up white and yellow tilly subsoil, as unpromising in appearance as possible. The weather being very dry, this till became so hard, that part of the field had to be rolled four times, before they were reduced to powder, and after all the operations, there was apparently no sap left in the ground. White turnips were sown, came away, one half being eaten off by sheep; and when the land was ploughed up in spring 1842, it turned up to appearance a fine rich dark mould, rising in friable clods, and not a particle of till to be seen. No one need be afraid to bring up subsoil of any kind on thorough-drained land after the experience at Yester.

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* Prize Essays of the Highland and Agricultural Society, vol. xii. p. 522.

† Ibid., vol. xii. p. 526.

† Smith's Remarks on Thorough Draining, p. 25.

(1210.) The advocates of subsoil ploughing seem to lay great stress on the laying of ground quite flat after that operation has followed throrough-draining, and of showing no open furrows in the field; because an uniform surface is the best for absorbing the rain, and transmitting it in the purest state to the drains. All this, however, is not peculiar to subsoil ploughing, for trenched land can be so treated, if desired. But as to dispensing with open furrows, the plan savours more of conceit than of possessing real utility. There is no way that has been contrived of ploughing land so conveniently as in ridges, a portion of ground being allotted to each ploughman, who is responsible for his own work; and the operations of sowing and reaping are easily marked off in equal distances to the work-people; and if in conducting all these operations few open furrows seem desirable, there is the mode of ploughing by two-out-and-two-in, fig. 138, which only leaves one open furrow in every four ridges, and the ground as flat as you please. But the truth is, that a field cannot be ploughed without making an open furrow, but with either one plough making a feering in the middle and turning over the whole ground, or, if more than one plough is employed, they must follow one another in adjoining furrows,—a plan inimical to good ploughing, inasmuch as no ploughman can hold so steady a furrow as when following up his own method of ploughing, and few ploughs are exactly of the same gauge on the furrow-sole; or the land must be ploughed with a turn-wrest plough, beginning at one end and finishing at the other of the field, ploughing the whole of it itself, or followed by others of the same sort; but where such ploughs are used for such a purpose, other common ploughs must be provided on the same farm, as land for turnips or potatoes cannot be drilled up with the turn-wrest plough, as you will learn by and by.

(1211.) The nature of *moor-band pan* is given below, and as to its destruction, although I have not had much experience of its obduracy, any case within my experience not exceeding 2 or 3 inches in thickness, which were easily ripped up with the 4-horse plough, and as easily mouldered down to dust on exposure to the winter's frost, yet there are places, such as in Aberdeenshire and Morayshire, where it is so deep and hard that extraordinary means are required to break it up. A remarkable and extensive band of this substance was encountered by Mr Roderick Gray, Peterhead, when improving a part of the property of the Governors of the Merchants' Maiden Hospital of Edinburgh in that neighbourhood. The moory surface was ploughed with 4 horses. "At first the plough ran upon the pan, which it seemed impossible to penetrate; various trials were made, and the plan which ultimately succeeded was to have 4 men employed at the plough, and these were engaged as follows:—One with a pick and spade made a hole where necessary, until it reached below the pan, and entered the plough at this hole; another held the plough; the third held down the beam, and kept the plough below the pan; and the fourth took care of the horses. In this way the upper stratum and pan were broken, and afterwards they were brought into a sort of mould by the grubber and harrows."* However obdurate this substance may be to break up, it will yield to the air, and moulder down into an innocuous powder of sand and gravel; but I should suppose that, after the plough was fairly entered below the crust, it would not require to be held down.

(1212.) [In describing the simple construction of the subsoil plough, I shall not go to any length into its history. The implement, as now used, is generally known as Smith's subsoil plough, having been brought into the present form by Mr Smith, Deanston Works, who, in the year 1829, exhibited this plough at the Highland and Agricultural Society's Show at Dumfries, and obtained a premium from the Society for his invention and application of this useful implement.†

(1213.) There is no doubt that ploughs, acting on the principle of Mr Smith's, penetrating into, breaking, and stirring up the subsoil, without bringing it to the surface, or mixing it in the first instance with the incumbent soil, have been long known. Mr Holt, in his View of the Agriculture of the County of Lancaster, rendered in 1794 to the Board of Agriculture, when treating of the ploughs of that county, says, "Another instrument has been lately introduced, which Mr Eccleston with propriety calls the *Miner*, which is a ploughshare fixed in a strong beam, without mould-boards, and drawn by four or more horses, and follows in the furrow the plough [the common plough] has just made; and, without turning up the substratum, penetrates into and loosens from 8 to 12 inches deeper than the plough has before gone; which operation, besides draining the land, causes the water to carry along with it any vitriolic or other noxious matter by the substratum thus loosened. The roots of plants may penetrate deeper; and, in course of time, that which is but a barren substance, may become fertile soil." This is truly the subsoil plough of Mr Smith, invented, laid aside, and forgotten for a period of 35 years.

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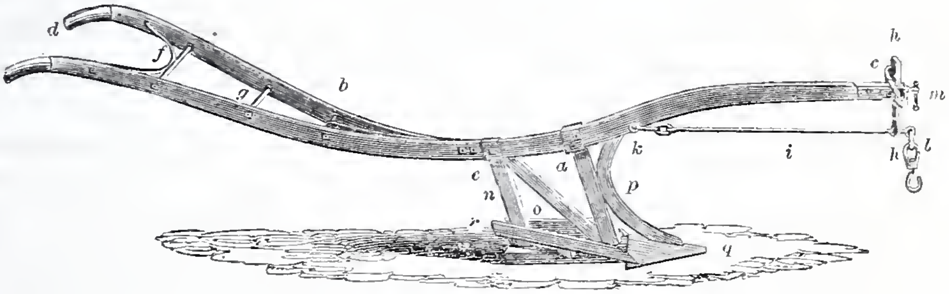
* Prize Essays of the Highland and Agricultural Society, vol. viii. p. 169.

† Ibid., vol. viii. p. 206.

(1214.) Recent experience points out the reason why the earlier introduction of the subsoil plough did not meet with the success which has attended Mr Smith's, which, from the above description, appears to be the same implement, for they appear in the essential parts to be almost exactly alike; yet the one has been lost sight of, while the other has come into all that notice which it deserves. The reason is now obvious: Without the necessary improvement of thorough-draining, subsoil ploughing is thrown away; and though thorough, or at least furrow, draining, has been practised in England for a long period,* the idea of combining the two seems not to have occurred to the agriculturists of that day. To Mr Smith, therefore, is still due the merit of having brought these two powerful auxiliaries of agriculture into effective co-operation.

(1215.) Since its first appearance in 1829, Mr Smith's plough has undergone various slight alterations, not affecting, however, its essential character, but chiefly in lightening its construction. The implement at first was made of enormous weight, sometimes so much as 5 cwt., but a few years' experience served to show that all its objects could be achieved with a plough of little more than half that weight; they are accordingly now generally made from 2 to 3 cwt. Fig. 207 represents one of the modifications of the subsoil plough as now manufactured by James Slight & Co., Edinburgh. It retains all the acting parts of Mr Smith's without material change, except in weight, though in other respects it deviates slightly from the original. The beam, which is from 3 to 3½ inches deep at the fore sheath or slot, *a*, and 1 to 1¼ inches thick, extends from *b* to *c*, a length of 7 feet 4 inches; at *c*, the point, it is diminished to 2¼ by ¾ inches, and at *b* to about the same dimensions. The two handles, extending from *d* to

Fig. 207.



THE DEANSTON SUBSOIL PLOUGH.

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* See Sir James Graham's observations on the subject in vol. i. p. 30 of the Journal of the Royal Agricultural Society of England.

c, are 6 feet 9 inches in length. They are thinned off at *c*, and bolted, one on each side, to the beam; the depth of the handles is 2 to $2\frac{1}{4}$ inches, and are $\frac{5}{8}$ to $\frac{1}{2}$ inch thick, worked into sockets at *d* in the usual manner for the reception of a wooden helve. The beam and handles are further connected by stretcher-tubes and bolts, the latter passing through all three at *b*, and binding them firmly together; the handles are also further supported by the stretcher-bolts and bow, *f* and *g*. The beam is mounted at *c* with the bridle, which is at least 2 inches by $\frac{1}{2}$ inch, bolted on the point of the beam, being first formed into an oblong loop of 8 inches in length, standing at right angles to the beam, and having the opening vertical. To the front part of the loop is fitted a stout clasp, the two arms of which embrace the loop above and below, and admit of the slot *h h* to pass at once through them and the loop. The clasp and slot together have a motion along the loop right and left, and the slot itself has a motion vertically. The chain-bar, *i*, is attached to the beam at *k*, and passes through an eye in the lower end of the slot *h*; to the chain-bar is then attached the draught hook *l*, to which the yoke is applied. The motion above described of the slot *h*, and consequently of the chain-bar and draught hook, afford ready means of adjusting the earthing and landing of the plough, and the position is retained by means of the pinching screw *m*, which, by being screwed into the clasp, acts against the outside of the loop, drawing the slot and the loop into firm contact. The body consists of the two slots *a* and *n*, the first about 3 inches broad, the last about $2\frac{1}{2}$ inches, and each $\frac{3}{4}$ inch thick; they are welded to a sole bar 2 inches square, and 30 inches long, flush on the land side. The head of the slots is worked into a kneed palm, which is strongly bolted to the beam, and the diagonal brace *o*, is fitted in to resist the strain that tends to derange the form of the body. The coulter-bar *p* is 3 inches broad, $\frac{3}{4}$ inch thick at the back in the upper parts, becoming thinner downwards, and is finished with a blunt edge and point; it is simply held in its place by being tongued into the beam, the fore slot, and the share. The share *q* is made after the same form as that of the common plough, having a feather to the furrow side, and is spear pointed. The length of the share is from 14 to 16 inches, and the breadth over the feather about 6 inches. It is fitted upon the prolongation of the sole bar, and its socket is usually furnished with a short ear, by which it is fixed to the sole bar to prevent its falling off, as the fixture of the coulter depends upon the share keeping its place. The feather *r* is a thin edged bar, 3 inches deep and about $\frac{1}{2}$ inch thick, thinned off on the upper edge; it is tapered off at the fore end where it joins the share, and is held in contact by being notched into it; but its chief supports are two palms, by which it is bolted to the sole bar; and a sole shoe of cast iron, having a flange rising 6 inches on the land side, completes the subsoil plough, which, with the exception of the sole shoe, is constructed entirely of malleable iron. The length of the plough over all is about 13 feet; the length of the sole 3 feet 3 inches; the height of the handles 3 feet 6 inches; and at the point of the beam 2 feet 4 inches.—J. S.]

(1216.) [Not much need be said regarding the efficacy of subsoil-ploughing. After what I have stated of the immense value of a mixture of impalpable matter, and larger particles, in the form of a porous mass, I need scarcely say, that anything capable of increasing the depth to which this porosity extends, must of necessity be advantageous. This, however, does not shew any difference betwen sub-soil and trench-ploughing—in my opinion, the latter is the best in most instances, and this for the following reasons. All subsoils require ameliorating by exposure to air, before they are capable of acting beneficially to plants—this is owing to certain chemical changes which are produced by the joint action of air and water, and it is very evident that all these must take place much more rapidly, when the subsoil, as in trench-ploughing, is laid *upon the surface* of the field, and freely exposed throughout the winter, than when the air is merely admitted more freely by the subsoil being *broken up* while it still remains *under the surface.* It may be averred that the trench-plough does not go so deep into the soil as the subsoil-plough, but still I cannot help thinking that notwithstanding this disadvantage (if any such exists), it is in most cases the most advisable of the two methods, if employed for *deepening* the soil. Not so, however, if used to assist in *draining the subsoil.* To prove its value for this purpose, I would earnestly direct your attention to the following valuable remarks of Professor Johnston:—"The subsoil plough is an *auxiliary* to the drain—in very stiff clay subsoils it is most advantageous in loosening the under layers of clay, and allowing the water to find a ready escape downwards, and to either side until it reach the drains. It is well known that if a piece of stiff clay be cut into the shape of a brick, and then allowed to dry, it will contract and harden—cut up *while wet*, it will only be divided into so many pieces, each of which will harden when dry, or the whole of which will again attach themselves, and stick together if exposed to pressure. But tear it asunder *when dry*, and it will fall into many pieces, will more or less crumble, and will readily admit the air into its inner parts. So it is with a clay subsoil. After the land is provided with drains, the subsoil being very retentive, the subsoil-plough is used to open it up—to *let out the water*, and to let in the air. If this is not done, the stiff under-clay will contract and *bake as it dries*, but it will neither sufficiently admit the air"—nor let out the water—"nor open a free passage for the roots. But let this operation be performed when the clay is still too wet, a good effect will follow in the first instance; but after a while the cut clay will again *cohere*, and the farmer will pronounce subsoiling to be a useless expense *upon his land.* Defer the use of the subsoil-plough till the clay is dry—it will then *tear* and *break* instead of *cutting*, and the openness will remain. Once give the air free access, and it, after a time, so modifies the drained clay, that it has no longer an equal tendency to cohere. Mr Smith of Deanston very judicially recommends that the subsoil-plough should *never* be used till at least *a year* after the land has been thoroughly drained. To attain those benefits which attend the adoption of improved methods of culture, . . . let the practical man make his trial *in the ways and with the precautions recommended by the author of the method*, before he pronounce its condemnation."* Thus you perceive that subsoil-ploughing *when properly performed*, will always be found useful in assisting the action of *drains*, but cannot be considered equal to deep or trench-ploughing, if an alteration is desired in the *depth of the soil.*

(1217.) Another alleged advantage of subsoiling is the breaking in pieces the *moor-band pan.* I will therefore now say a few words respecting this enemy to good farmers. This ferruginous deposite which so frequently occurs in particular localities between the soil and subsoil is extremely hard and compact, and almost completely impermeable to water. Very much has been written concerning this substance, by persons who have but little knowledge of chemistry, and in their endeavours to prove the manner in which the deposite had been produced, and likewise the cause of its injurious action upon vegetation when newly brought to the surface, have made so many chemical errors, that the whole subject appears at first sight wrapped in doubt, whereas, we believe, that for all practical purposes its nature is already sufficiently well known.

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* Johnston's Elements of Agricultural Chemistry, p. 126.

(1218.) Moor-band pan belongs to a class of bodies known to chemists under the name of *ochrey deposites.* These deposites, which so frequently occur in the beds of chalybeate springs, were carefully examined by Berzelius in 1832; and were found to consist of the two oxides of iron in chemical combination with two new organic acids, which he denominated the *crenic* and *apocrenic acids.* Feeling certain from various circumstances, that moor-band pan belonged to this class, I undertook an analysis to ascertain whether it contained these acids, and find that in each of two specimens of pan, sent to me for the purpose, there exists a large proportion of *crenic acid*, in one *apocrenic* also, and in the other *humic acid;* there can therefore be no longer any doubt about the composition of this substance: and, instead of attempting to prove its injurious effects by relating the difference between the protoxide and peroxide of iron, and the fact of the peroxide being generally combined with water forming *hydrate,* none of which facts throw the least light upon the subject; we can readily explain all by reference to the chemical properties of the compounds of these two acids with iron. It is well known that iron *in solution* acts injuriously upon vegetation; and Berzelius has shewn, that the *crenate* and *apocrenate* of the protoxide of iron are both *soluble in water;* and that the same salts of the peroxide, although of themselves insoluble, are easily rendered so by ammonia, which substance is always produced in fertile soil; it follows, therefore, that moor-band pan must continue injurious to vegetation so long as the *crenates* and *apocrenates* of iron remain undecomposed. In the course of time, various chemical changes are effected by the joint action of air and moisture which decompose these compounds, and give rise to new ones having no injurious effect upon vegetation.—H. R. M.]

END OF VOLUME I.

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THE BOOK OF THE FARM.

THE

BOOK OF THE FARM,

DETAILING THE LABOURS OF THE

FARMER, STEWARD, PLOUGHMAN, HEDGER, CATTLE-MAN,
SHEPHERD, FIELD-WORKER, AND DAIRYMAID.

BY

HENRY STEPHENS.

IN TWO VOLUMES.

WITH NUMEROUS ILLUSTRATIONS.

VOL. I.

WILLIAM BLACKWOOD AND SONS,
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TWO HUNDRED AND SEVEN WOOD ENGRAVINGS.

NOTE.

The Author requests his Readers to bear in mind, that the text of the Book of the Farm will be found in the larger type, and that the smaller consists of annotations and illustrations, and of descriptions of complicated Machines, which are placed there that they may not interfere with the narrative of operations contained in the text itself, while, as having reference to it, they can be there more conveniently consulted, than if thrown into the form of an Appendix at the conclusion of the work.

The Author will feel greatly indebted to any of his numerous Agricultural Friends who will take the trouble of transmitting to him whatever remarks and practical conclusions their experience and personal observation have suggested to them.

ILLUSTRATIONS

INSERTED IN

PART I.

PLATE I. ISOMETRICAL VIEW OF AN EXISTING STEADING.
II. GROUND PLAN OF AN EXISTING STEADING.
VII. DRAUGHT HORSE.

PART II.

III. ISOMETRICAL VIEW OF A PROPOSED STEADING.
IV. GROUND PLAN OF A PROPOSED STEADING.
TWENTY-SEVEN WOODCUTS.

PART III.

VI. SHORT HORN OX.
VIII. BROOD-SOW.
TWO WOODCUTS.

PART IV.

XIV. LEICESTER EWE & LAMBS.
XV. SHORT HORN COWS.
ELEVEN WOODCUTS.

PART V.

XVI. DRAUGHT STALLION.
IX. LANARKSHIRE OR WILKIE'S PLOUGH.
XI. ANALYTICAL SECTIONS OF MOULD BOARDS.
SEVENTY-ONE WOODCUTS.

PART VI.

V. EAST-LOTHIAN OR SMALL'S PLOUGH
X. MID-LOTHIAN OR CURRIE PLOUGH.
XII. ANALYTICAL SECTIONS OF MOULD BOARDS.
FIFTY-ONE WOODCUTS.

PART VII.

XIII. DRAUGHT OF THE PLOUGH.
XVII. DRAUGHT MARE.
TWENTY-ONE WOODCUTS.

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